

NRD RESOURCE ROOM

environmental assessment

development concept

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BIG BEND CHISOS BASIN

NATIONAL PARK / TEXAS





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ENVIRONMENTAL
ASSESSMENT
FOR THE CHISOS BASIN
DEVELOPMENT
CONCEPT

Big Bend
National Park
Texas

United States Department of the Interior
National Park Service

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the region



not to scale

155 | 20008
May 73 | DSC

United States Department of the Interior
National Park Service

figure 1



General View of Dallas Huts and Ranger Station (foreground)

PROBLEM STATEMENT

The Chisos Basin area of Big Bend National Park has sustained a great amount of adverse environmental impact due to inappropriate placement and poor quality of some of the facilities that serve and support visitor use of the basin. Increased visitation to Big Bend National Park, from 114,232 in 1963 to 341,200 in 1973, combined with the popularity of Chisos Basin, one of the main attractions in the park, has resulted in heavy use of these existing, albeit mostly substandard, facilities. This assessment addresses the following specific problems in Chisos Basin:

The inappropriate siting, disorganized arrangement, and substandard condition of facilities in the basin detracts from the visitor's experience by cluttering his view of otherwise wide scenic vistas. Overhead powerlines and scarred roadbanks are also visual intrusions.

Poorly sited facilities, extensive paved surfaces, and visitor activities have altered the basin terrain and natural drainage patterns.

The activities of man have created many new disturbed habitats. In places the natural vegetation has been eliminated, thus promoting the introduction of new vegetation types.

Concessioner employee housing and maintenance facilities — a conglomeration of Dallas huts, trailers, and other substandard structures — are inadequate to support a sound concession operation for providing overnight accommodations and food services for visitors.

Some visitor accommodations, particularly the Dallas huts, are deteriorated structures that are difficult to maintain at an acceptable standard.

The saddle-horse operation, the Chisos Remuda, results in impacts that are difficult to assess and deal with because of the many factors influenced by this operation. Adverse ecological effects upon vegetation result from maintaining an unnaturally large population of horses in an unusually small environment and from riding horses over park trails.

The sewage lagoons are no longer acceptable sewage-treatment facilities under current Texas State Health Department standards.

The Impact of Human Use Upon the Chisos Basin and Adjacent Lands (Whitson 1970) identifies and documents the adverse environmental effects of the situation in Chisos Basin and recommends that positive action be taken to ameliorate them.

Because the major form of activity in the basin centers around exposing the visitor to the unique landscape, efforts must be made to provide services in the smallest area possible and with the least effect upon the total environment. Plans will not be considered that would expand the extent of impacted areas. Instead, a vigorous rehabilitative program should be initiated to provide more natural vegetation in both the upper and lower basins (Whitson 1970).

Consequently, the alternatives that are considered feasible are based on concepts such as reusing vacated building sites to reduce clearing of new land for new facilities; designating open-space zones to preserve scenic vistas; and considering areas outside the basin for relocation of activities and facilities.

The alternatives presented in this assessment were generated by a comprehensive look at the entire Chisos Basin development. They include, but are not limited to, the suggested concepts presented in the master plan for Big Bend, which are:

- Maintaining within the basin only those concessioner employee housing and maintenance facilities directly required for the operation of the Chisos Basin development. Those facilities that are substandard would be replaced with new units to be built in already impacted areas.

- Replacing the Dallas hut visitor accommodations with new units to be built in already impacted areas.

- Retaining and improving the campground.

- Making no further accommodation for automobiles.

- Relocating the saddle-horse concession to a suitable site outside the basin.

The environmental statement being prepared for the proposed master plan also addresses these concepts, but in broad terms only.

This environmental assessment examines the various feasible alternatives for developing Chisos Basin, and their impacts. Subsequent to public meetings and other public involvement relating to this environmental assessment, a development concept plan for Chisos Basin will be prepared as a plan of action for improving functional relationships between visitor use, resource management, and maintenance. This plan will be followed by a comprehensive design plan.

The development concept plan generated by this assessment will be implemented jointly by the National Park Service and the two park concessioners, National Park Concessions, Inc., and Chisos Remuda.

BIG BEND NATIONAL PARK CHISOS BASIN



Major Views

United States Department of the Interior
National Park Service

Figure 2



Close-up View of Dallas Hut

DESCRIPTION OF THE ENVIRONMENT

MAJOR NATURAL FEATURES

Big Bend National Park, encompassing 708,221 acres, was established by Congress on June 12, 1944, for the purpose of preserving an outstanding example of rugged Chihuahuan Desert wilderness, a significant section of the Rio Grande and its associated canyons, and desert mountains, with their various unique ecological communities. A number of plant and animal species native to Big Bend are found nowhere else in the United States.

Visually dominating the central portion of the park are the Chisos Mountains, a compact range of rounded rocks, vertical cliffs, and deep canyons that are the eroded remnants of a complex series of interbedded granites, lavas, and sediments. The Chisos are the southernmost mountain range in the United States and the only one lying entirely within a national park.

Chisos Basin, with its cool, woodland environment, so different in character from the harsh lowlands, is a primary destination point for park visitors. This 6-square-mile bowl-shaped depression within the Chisos has long been the focal point of visitor activities and their related facilities. Unusual geologic formations, such as Casa Grande and the Window, provide scenic interest within the basin.

developed area	facility																
		INFORMATION	INTERPRETATION	VISITOR CENTER	CAMP/ROUND	TRAILER CAMP	PICNIC AREA	AMPHITHEATER	INTERP TRAILS	REMNICA	RANGER STATION	MOTEL	FOOD SERVICE	STORE	GAS STATION	ADMIN OFFICES	HOUSING NPS
	castolon	11							1				1				
	chisos basin	1						2	1	1			1	1			
	maye-rick	1							1							1	
	panther junction		1														
	persim-mon gap	1							1							1	
	rio grande village	11				1			1								

legend/notes

PROPOSED FACILITY

EXISTING FACILITY

1 FACILITY IN NEED OF RENOVATION, REPLACEMENT AND/OR EXPANSION

2 FACILITY TO BE RELOCATED

matrix: developed area / facility

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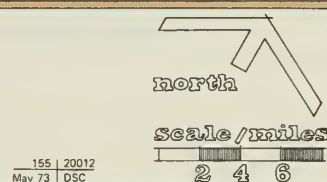
figure 3



legend:

- major road - improved
- ▬ minor road - primitive
- ⋯ trail
- * use node
- i interpretive node
- f fish/float camp

general development



United States Department of the Interior
National Park Service

figure 4

EXISTING DEVELOPMENT

Most overnight accommodations, service centers, and support facilities are located in the development complex in the upper basin. The lower basin is primarily for camping and picnicking. Recreational opportunities are afforded by an extensive trail system, which enables visitors to explore the natural setting of the basin. The remuda concession in the lower basin makes saddle-horses available to visitors.

TABLE 1

Existing Facilities in the Chisos Basin.

Upper Basin	Number of	
	Units	Pillows
Overnight accommodations		
Motel-type units	20	80
Stone/adobe cottages	6	36
Lodge units	8	23
Dallas huts	21	68
Totals	55	207
Service centers		
Laundry/showers		
Lodge		
Restaurant		
Coffee shop		
Curio shop		
Store concession		
Ranger/contact station		
Gas station		
Ice storage		
Sales		
Comfort station		

	Number of Units	Employees
Support facilities		
Concessioner employee housing	17	60
Dallas huts		
Trailers		
Miscellaneous structures		
Concession-maintenance warehouse		
5,000-gallon water-storage tank		
2,000-gallon liquified petroleum gas facility		
223 parking spaces		

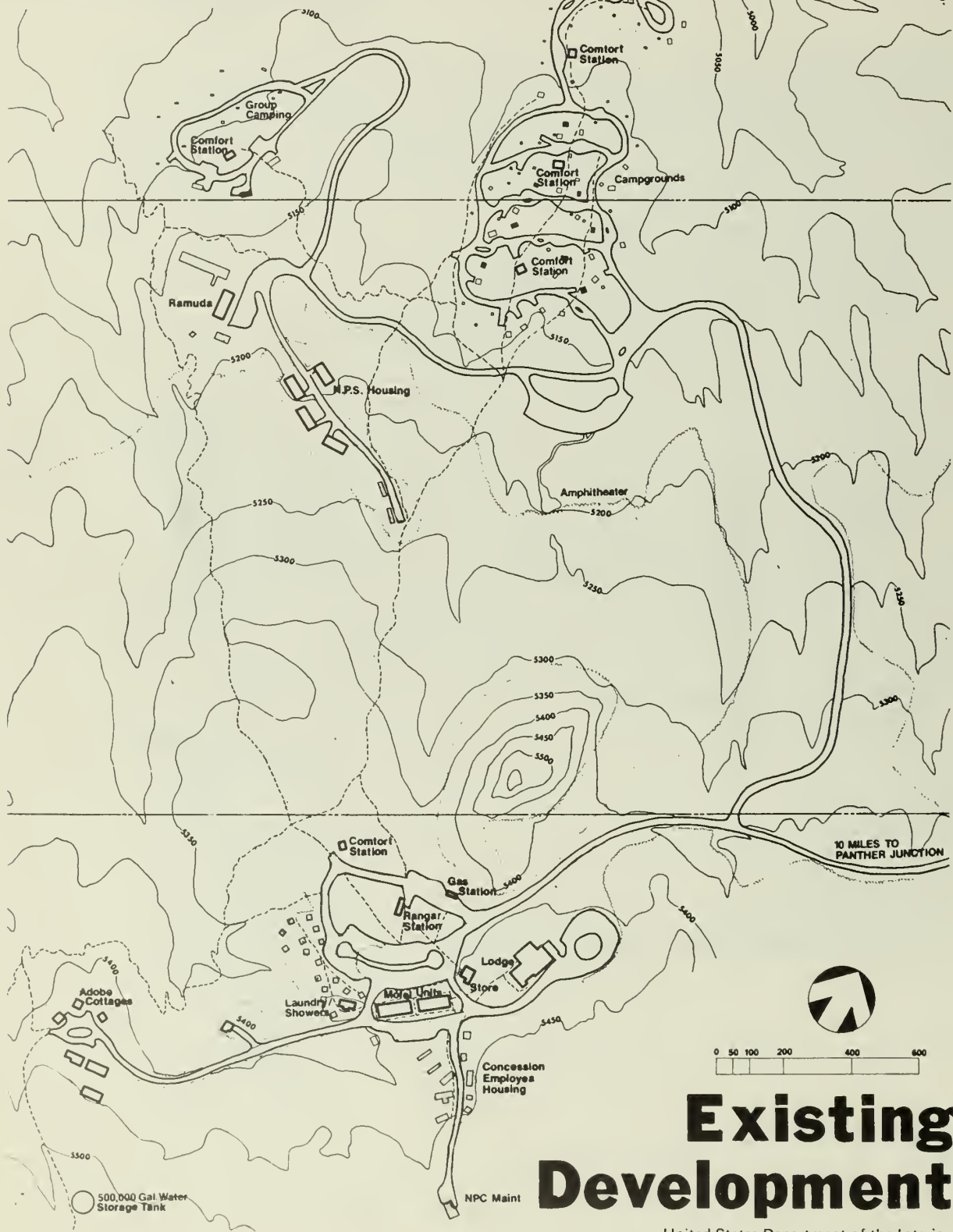
Lower Basin

Overnight accommodations	
Campground	
71 family campsites with 34 ramadas	
3 group campsites with ramadas	
comfort stations	

Service centers	
Saddle-horse concession (remuda)	
Amphitheater	

Support facilities	
NPS employee housing	
4 units	
2 trailers	
147 parking spaces	
Sewage-treatment plant with two sewage lagoons	

BIG BEND NATIONAL PARK CHISOS BASIN



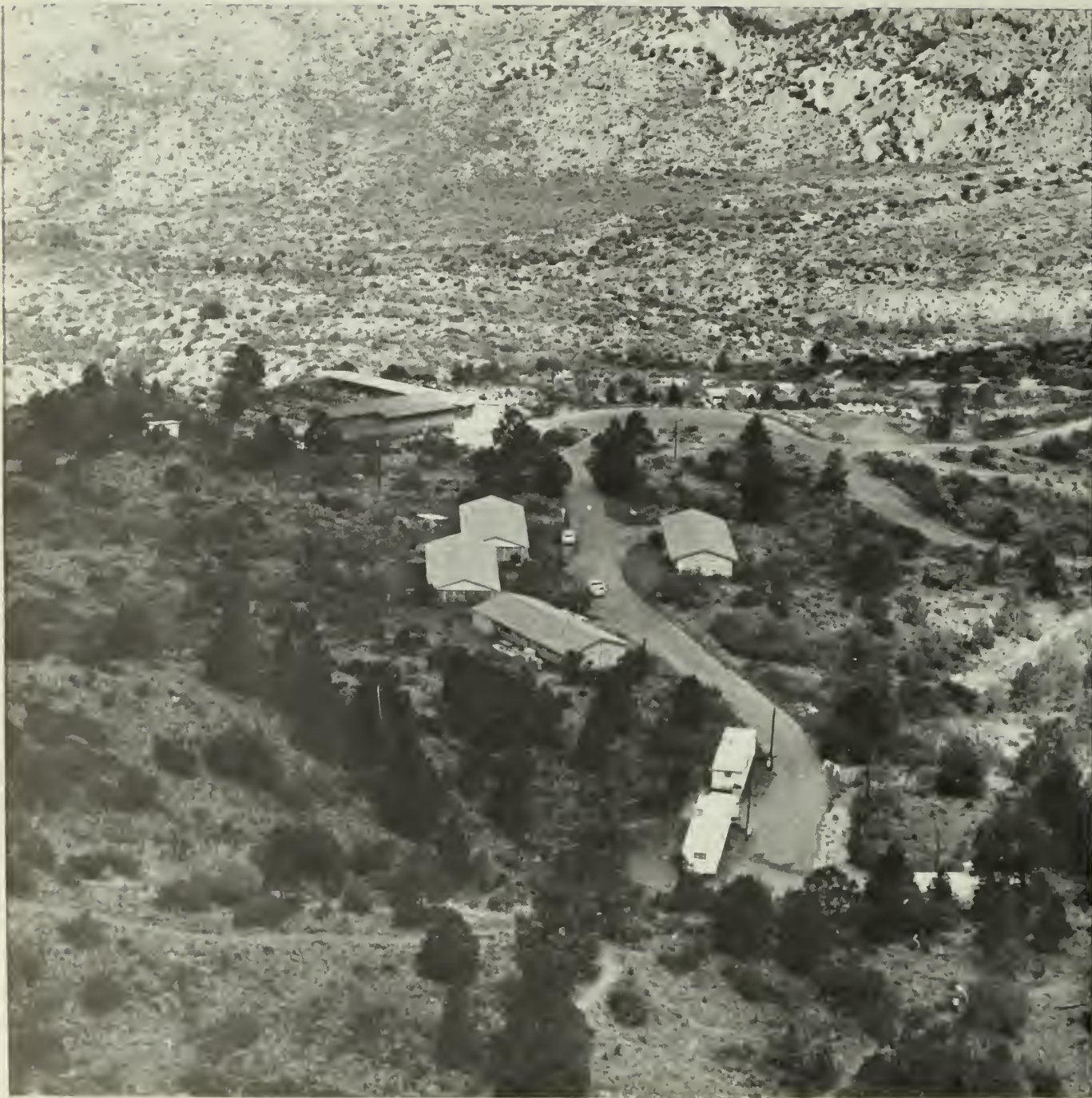
Existing Development

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National Park Service

Figure 5



Concessioner Employee Housing (upper left), New Motel Units (lower right), and Store (foreground)



NPS Employee Housing and Chisos Remuda (background)



Corrals at Remuda



General View of Campground (looking north)



Tent Camp in the Campground

The campground occupies a former Civilian Conservation Corps campsite established in the mid-1930's and used until about 1942. During that period, the area was completely denuded of vegetation. Subsequent to the establishment of the park, the site was used as park headquarters, with some buildings being converted into administrative spaces and others into residences. Park headquarters was moved to Panther Junction in 1956, but the residences continued to be occupied until they were razed in 1958 or 1959. The campground was constructed about 1958. The site has recovered somewhat from its previous denuded condition, but because of its present use as a campground, complete revegetation is impossible.

GEOLOGY AND PHYSIOGRAPHY

The Chisos Mountains are the highest topographic feature in Big Bend National Park, rising up to 7,800 feet. The Chisos Basin is a central depression lying 1,500 to 2,000 feet below the highest mountains. The surrounding walls, composed of igneous (molten origin) rocks, consist of the Ward-Pulliam intrusion (formed within the earth's surface) on the west and north sides, and the massive lavas (formed outside the earth's surface) of Casa Grande, Toll, and Emory Peaks bordering the east and south sides. The floor of the basin was carved from soft sedimentary rocks and younger volcanics, which were uplifted and eroded to form the basin as it exists today.

The basin floor consists of bentonitic clay and soft sedimentary rocks, mostly covered by boulders and gravel. Occasionally, when the clay becomes wet to some depths, both the boulders and clay move down the steep slopes, and they form ridges when the forward motion ceases. The Boulder Meadows were formed by this process (Maxwell 1967).

Much of the basin is covered by alluvial deposits, essentially gravels, sands, and clays, that vary widely from place to place in thickness, degree of consolidation, and kind of material. Slopes are covered with talus (rubble), consolidated basin fills, and high terrace gravels.

Sedimentary rocks identified on the geologic map include the Chisos Formation, which consists of layers of volcanic ash interspersed with sands and clays. Older sedimentary rocks of Upper Cretaceous age consist of limestones, clays, and sandstones.

The soils of the Chisos Basin are species of the Trans-Pecos Land Resources area. No detailed soils studies have been made. However, in February 1973, Hubert B. Jaco, a soil scientist for the Soil Conservation Service, preliminarily delineated the Mainstay-Liv Association in the basin. The Mainstay series, found on the higher slopes of the mountains, is well drained and stoney, with 35 to 80 percent coarse fragments, and is less than 20 inches thick above the intrusive bedrock. The Liv soil series, found

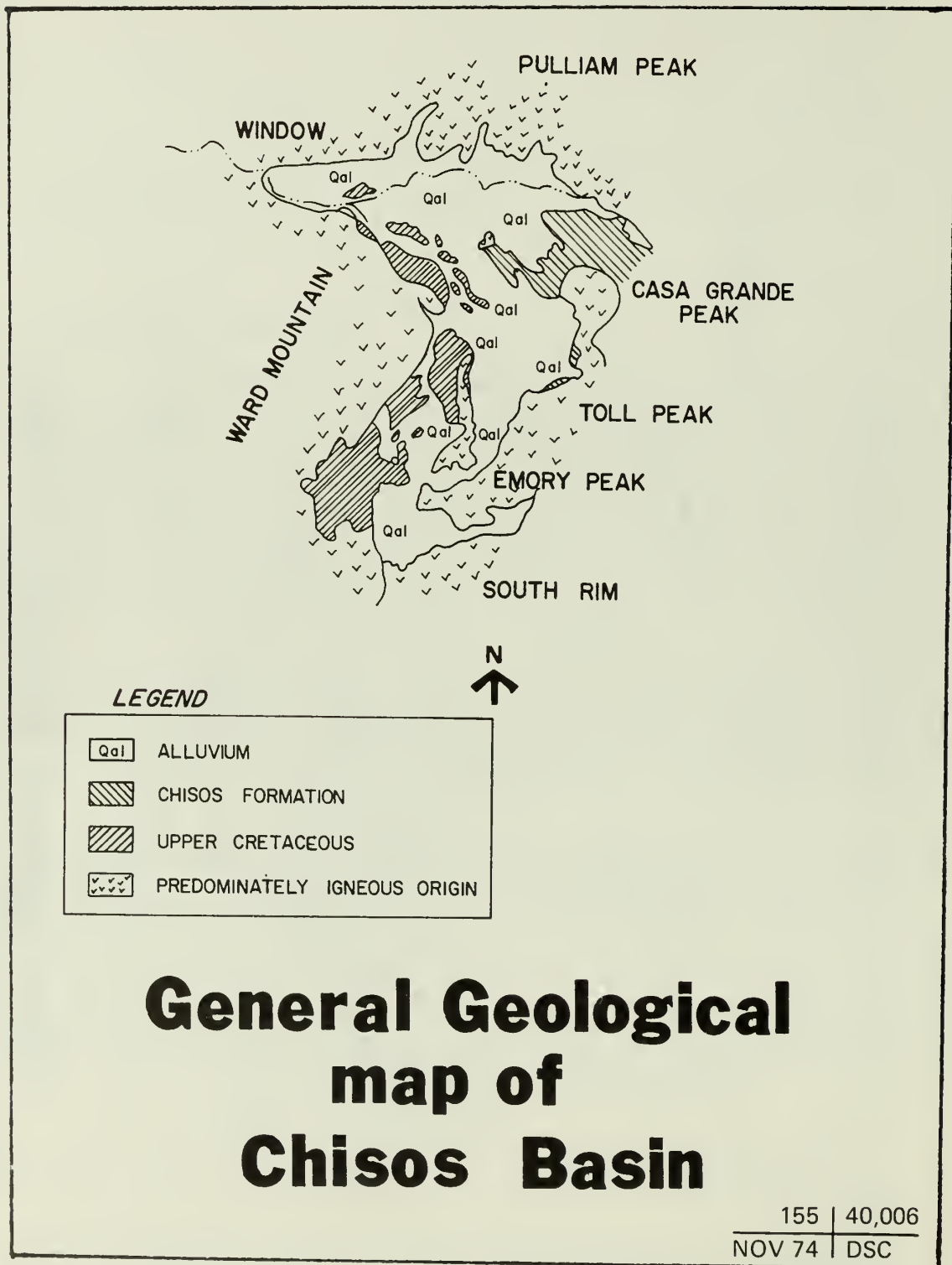


Figure 7

United States Department of the Interior
National Park Service

on the lower slopes of the mountains and in the valley, is also well drained, and also contains about 35 to 80 percent coarse fragments. This is a deeper series than the Mainstay – 21 to 40 inches thick over intrusive bedrock.

Volcanic ash, upon weathering, forms a clay, called bentonite, that is known to have high shrink/swell potential. All of the soils of the basin contain some expandable clay; those in the upper basin have a high and variable quantity caused by bentonite mixing with rock fragments. Engineering soils tests by Dames and Moore (Job No. 4473-001-12) and Hauskins and Beckwith (Job No. 71-255-1971), on file and available upon request from the National Park Service, show that the soils of the upper basin are extremely variable and have caused failures in existing structures. Onsite tests will be required for any proposed structure within this area.

Mass-movement of the soils and subsurface is evident, and this factor must be considered during construction of roads, walls, and buildings. The "lens" of bentonite soils in the upper basin development area presents a hydrological problem if runoff is retarded by structures in this expansive-clay area. These lenses will expand differentially, retarding water movement and creating structural failure.

Because of their slope and depth to bedrock, the Mainstay soils present severe limitations to developing ponds, pond embankments, foundations, septic tanks, sewage lagoons, roads, campsites, paths, and trails. This soil series is also corrosive to uncoated steel pipes.

The Liv series development limitations are similar to those of the Mainstay, but are generally not as severe. Recreation sites intended for intensive use should not be developed on these soils due to their slope and the presence of coarse fragments on the ground surface.

Cutting and grading of areas identified as having bentonitic soils is feasible, but none of the soil should be used as fill.

CLIMATE

Chisos Basin, at 5,400 feet, has a pleasantly cool and mild climate. The average annual temperature is 63° F., but seasonal temperatures vary widely. The mean daily maxima for November, December, January, and February are between 60° and 70° F., while the minima are between 37° and 47° F. For the months of March through October, the mean daily maxima range between 68° and 88° F., and mean daily minima range between 40° and 58° F. The warmest mean daily maxima and minima were both recorded in June. An average of 37 days each year can be expected to have temperatures above 90° F.

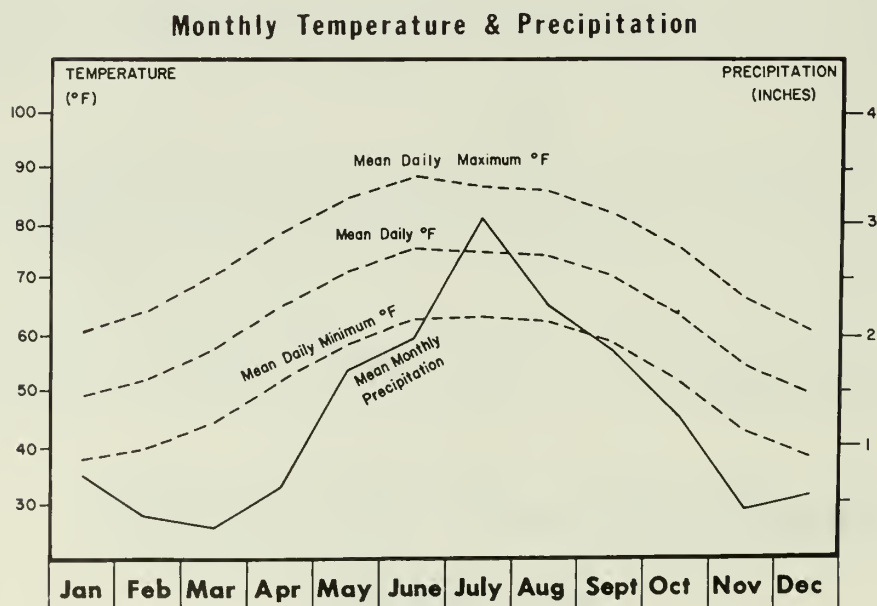
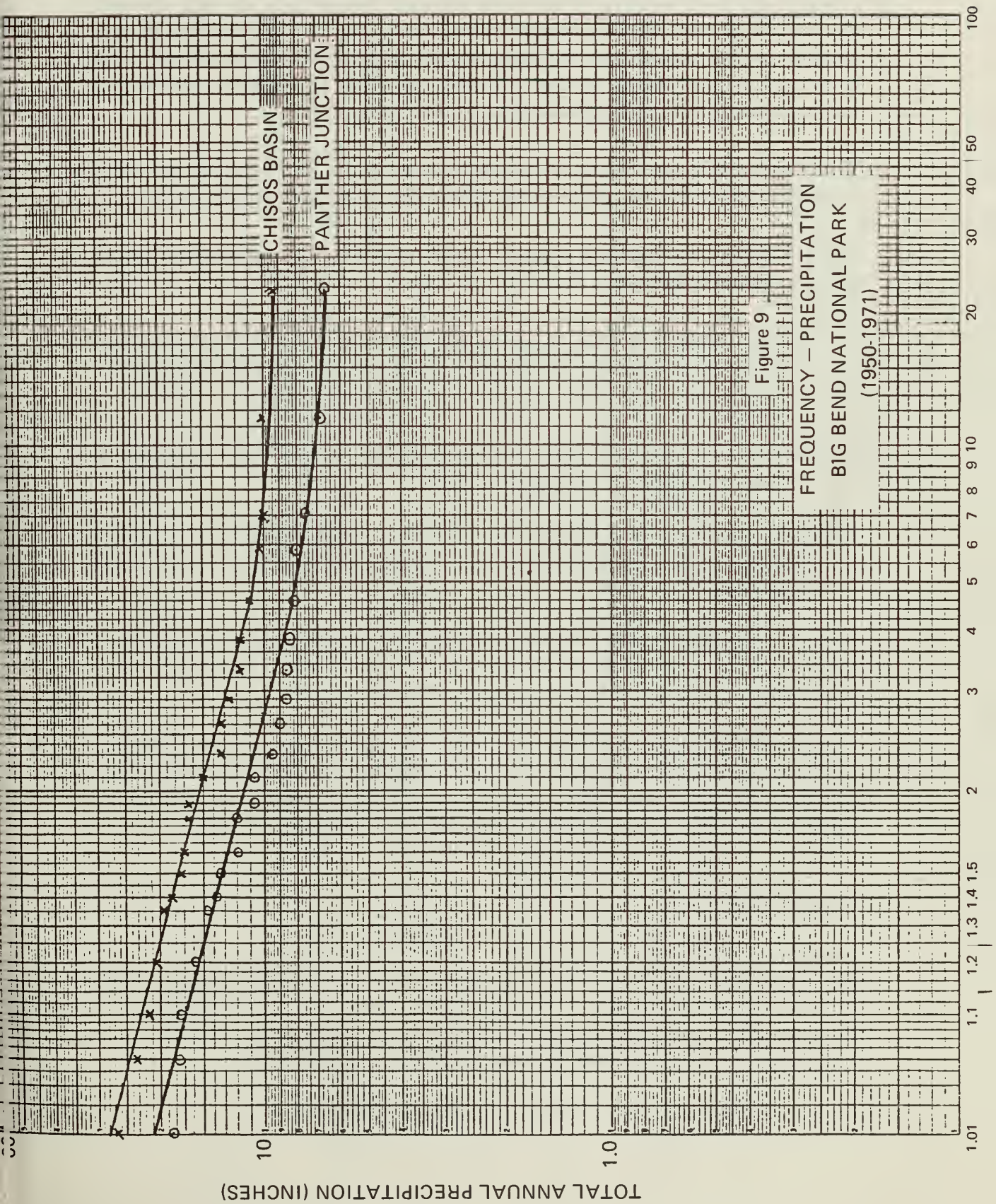


Figure 8

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION



Average annual rainfall between 1949 and 1973 was 17.72 inches. The rainy season at the basin is summer. Monthly rainfalls average more than an inch from May through October, with an average total for these 6 months of 12.10 inches. The wettest month is July, when precipitation averages 3 inches. The sparse snowfall/sleet averages 3.7 inches annually. The greatest snow depth on record is 9 inches.

The main source of moisture is the general circulation of air from the Gulf of Mexico during the warmer months, which results in brief but often intense summer showers.

Figure 9 shows the recurrence interval in years of total annual precipitation for the period of record (1950-1971).

The average monthly humidity has only been reported for the following months in 1958: April 35.4 percent, May 42.1 percent, June 75.9 percent, July 40.6 percent, August 44.8 percent.

Evaporation rates are not recorded. However, mean annual lake evaporation is estimated to be 70 inches per year (Water Atlas).

Included in the precipitation data for Chisos Basin is a severe drought, which began in July 1951 and lasted until September 1958. During that time, the average annual precipitation was 10.70 inches.

Drought conditions (defined as 10 inches or less) will statistically recur every 7 years at Chisos Basin. Multiple consecutive drought years were not determined because of lack of sufficient data.

Climatic differences are considerable in this mountainous region because each hill creates a variety of micro-climates. The crests have climates different from the valleys, and the windward slopes differ from the wind-protected slopes. The temperature decreases an average of one degree F. for each 300-foot increase in elevation.

HYDROLOGY

Surface Runoff

All surface drainage is directed to the Window, from which it enters Oak Creek. Time of concentration is estimated to be about 30 minutes. The time, however, may be accelerated because of manmade channelization of water due to development in the area. The average watershed slope is computed to be a 14 percent grade.

No studies have been made to relate runoff with intensity of rainfall.

By Development as of *Chukchi Basin!*

Big Bend National Park

Table 2

Area (Water System)	Priority Date	State Permit #	Source	Type	WELL DATA				WELL HYDRAULIC DATA				Remarks
					Depth (ft)	Dia-meter (in)	Length Casing (ft)	Screen Length (ft)	Static (ft)	Spec. Cap.	Yield (G.P.M)	Date Measured	
Upper Basin #1	8/1/40	-	Well	Drilled	400	8	380	-	100		70	8/2/40	Not used
	Original owner - Texas State Park Board; Contractor - Tony Hess Alpine, Texas Water Bearing Zone - 385' deep in sandstone. Formation - Aguja Formation (Maxwell)												
Upper Basin #2	1947		Well	Drilled	1160	8 to 375' 7 to 801'	801	250-274			25-30	10/14/74	Not used
	Original owner - National Park Service; Contractor - Parker & Jones Drilling Co., Iraan, Texas Water Bearing Zone - 268' deep. Formation - Hannold Hill Formation (Maxwell)												
Lower Basin CCC #1	Late 1930's		Well	Dug	38	6'x14'			9		5	3/12/65	Not used
	Original owner - Texas State Parks Board; Contractor - Unknown Water Bearing Zone - Surface. Formation - Alluvial Fill, Boulders and Clay												
Lower Basin CCC #2	1947		Well	Dug	30	4'x18'			8		5	3/12/65	Not used
	Original owner - National Park Service; Contractor - Unknown Water Bearing Zone - Surface. Formation - Alluvial Fill, Boulders and Clay												

Groundwater

Four wells have been drilled within the basin (table 2). Well drilling samples from upper basin wells 1 and 2 penetrated alternating layers of alluvial, clay, sand, sandstone, and shale formations. The water-bearing formation in both wells consisted of sandstone lenses at depths of 385 and 268 feet below ground level.

Recharge is direct from rainfall and is undoubtedly irregular and discontinuous, reflecting the variable nature of rainfall and runoff. Most of the recharge to groundwater probably occurs in early spring as a result of snow melt and during the summer and fall rainy season.

The physical characteristics of the surface soil, consisting of nearly 40 percent rock, 40 percent gravel, and 20 percent sand, are conducive to rapid infiltration of rainfall. The unconfined water table is commonly associated with a low ratio of storage to flow, resulting in considerable fluctuation.

Data in table 3 shows that waters found in the deeper aquifers are not comparable in chemical quality to the waters analyzed from Oak Springs. Water from the shallow wells more closely agrees with Oak Springs water, thus suggesting that they may be hydraulically connected.

Oak Springs

Oak Springs, located at 4,080 feet, approximately half a mile northwest of the Window, issues from conglomerate alluvial deposits. Its variable discharge probably reflects antecedent precipitation conditions in the Chisos Basin. It is presumed that Oak Springs and the basin are hydraulically connected through the jointed and fractured igneous intrusion located between them.

Under average conditions, the annual spring flow is equivalent to 0.7 percent of the total annual precipitation falling on Chisos Basin. Spring flows were measured 31 times between 1953 and 1972 by Government personnel, but records were not kept up between 1959 and 1969. The spring flows recorded varied from a base of 6.5 gallons per minute (1957) to 80 gpm (1968 and 1971). The average flow was 23.2 gpm. Figure 10 illustrates the percentage of time Oak Springs flow is equal to or less than indicated flow values.

Time of response of spring flow to antecedent precipitation conditions has not been determined. However, observations made by park personnel place it between 1 to 3 months later.

Oak Springs serves as the principal water source for all water needs within Chisos Basin.

Water quality is high and complies with U.S. Public Health Drinking Water Standards for all constituents except fluorides (3.3 to 3.6 parts per million) and iron (28 ppm), which are excessive.

QUALITY OF WATER REPORTS - CHEMICAL ANALYSIS
ALL AREAS - SOUTHWEST REGION, NATIONAL PARK SERVICE

Table 3

AREA	Big Bend National Park	Chisos Basin	Lower CCC Well #1	Upper CCC Well #1	Lower CCC Well #2	Upper CCC Well #2	Oak Spring	Oak Spring
SOURCE	Upper Basin Well #1	Upper Basin Well #2	Lower CCC Well #1	Upper CCC Well #1	Lower CCC Well #2	Upper CCC Well #2	Oak Spring	Oak Spring
DATE	2-7-42	7-6-47	12-3-65	12-3-65	12-3-65	12-3-65	12-3-65	12-3-65
Silica (SiO ₂)	13.		31.	30.	29.	28.	29.	41.
Iron (Fe)	<0.05		0.05	0.00	0.03	0.44	0.00	0.00
Manganese (Mn)	13.		24.	24.	24.	6.6	42.	65.
Calcium (Ca)	2.	30.	0.2	1.0	0.5	0.0	1.2	1.9
Magnesium (Mg)	202.	374.	27.	27.	27.	28.	27.	30.
Sodium (Na)			0.7	0.6	0.6	1.1	0.8	1.6
Potassium (K)	177.	182.	118.	119.	119.		141.	165.
Bicarbonate (HCO ₃)	30.		0.	0.	0.		0.	0.
Carbonate (CO ₃)	234.	402.	10.	11.	10.	11.	32.	101.
Sulfate (SO ₄)	28.	54.	5.2	4.8	5.4	6.8	5.2	5.0
Chloride (Cl)	6.	64.	2.8	3.4	2.8	3.0	3.2	4.3
Fluoride (F)	<0.4	0.2	2.0	2.1	2.1	1.5	3.9	0.0
Nitrate (NO ₃)	614.	935.	160.	163.	161.	116.	211.	339.
Dissolved Solids: Calculated	-	-	165.	160.	-	117.	210.	345.
Residue on evaporation at 180°C	40.	64.	61.	64.	62.	16.	110.	170.
Hardness as Ca CO ₃			0.	0.	0.	0.	0.	35.
Non-carbonate hardness			49.	47.	48.	78.	35.	32.
Percent Sodium % Na			1.5	1.5	1.5	3.0	1.1	1.3
Sodium Adsorption Ratio			340.	240.	238.	165.	331.	488.
Specific Conductance		120.	7.6	7.2	7.5	9.8	7.2	7.5
Unhos @ 25°C								

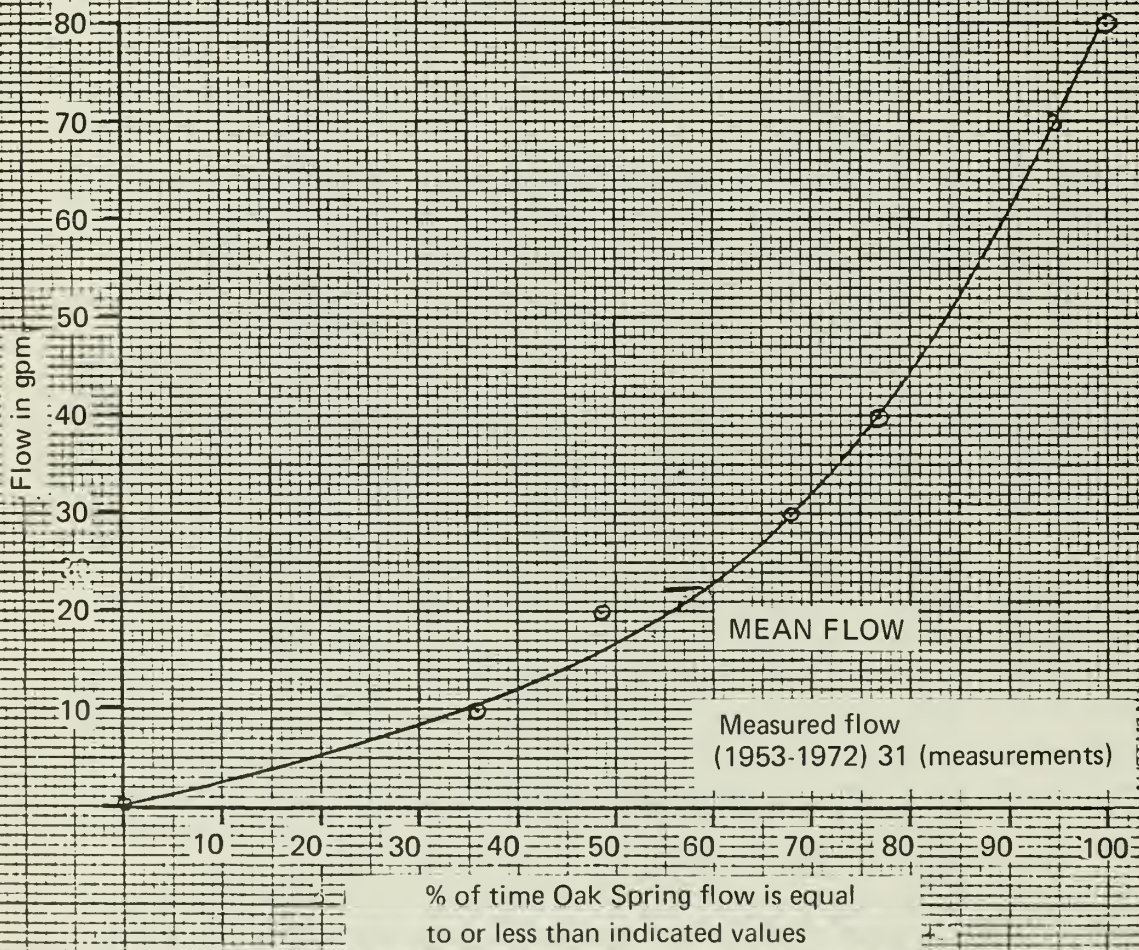


Figure 10

Cattail Spring

Located at an elevation of 4,640 feet, on top of Cattail Falls, this spring issues from sedimentary alluvials overlying an igneous intrusion. The drainage basin is approximately 2 square miles. All flow cascades into Cattail Canyon, which is directed radially outward from the Chisos Mountains.

Spring flows were measured 11 times between 1966 and 1972 by Government personnel. They varied from a minimum of 17 gpm to a maximum of 50 gpm.

Time of response of spring flow to antecedent precipitation conditions has not been determined. However, observations made by park personnel indicate it is immediate.

Water from Cattail Canyon is diverted as a supplemental source of water for the Chisos Basin developments. The water quality is high and complies with U.S. Public Health Drinking Water Standards.

Water Supply and Demand

In a 1972 investigation by the U.S. Geological Survey it was made clear that during drought periods total diversion of both Cattail and Oak Springs would not satisfy present basin water demands. The present total storage capacity of 1,025,000 gallons would supply the deficit for three months assuming no water conservation practices were adopted.

Water demand data (appendix C) indicate that at the present time (1973) the demand for water, which averages 21.4 gallons per minute, equals 92 percent of the average yearly spring flow from Oak Springs (23.4 gpm), and 323 percent of the minimum flow (base flow) from Oak Spring (6.5 gpm). The minimum flow from Oak Springs has been exceeded, but the economic consequences of overdevelopment of the fresh water resources will not be fully realized until the recurrence of the next multiple drought years similar to the years 1951 to 1957. Trucking of water from Panther Junction was the solution and most likely will be again, only with greater quantities of water delivered and at higher unit costs. The quantity of water available for transmission to Chisos Basin is also in question.

Projection of future water demands based on historical trends indicate that by 1980 the average yearly water demand could increase to 40 gpm (+177 percent average flow, +615 percent of base flow), thus increasing the severity of the water shortage and the potential that visitor services would have to be cut back, resulting in economic losses (see figure 11).

Because chemical analysis data suggests an interrelationship between the shallow groundwater table within the basin and the waters issuing from Oak Springs, any major development within the basin should be designed so as to reduce above-normal surface runoff, so that infiltration of rainfall into the shallow groundwater table can be maximized to ensure continued flow from Oak Springs.

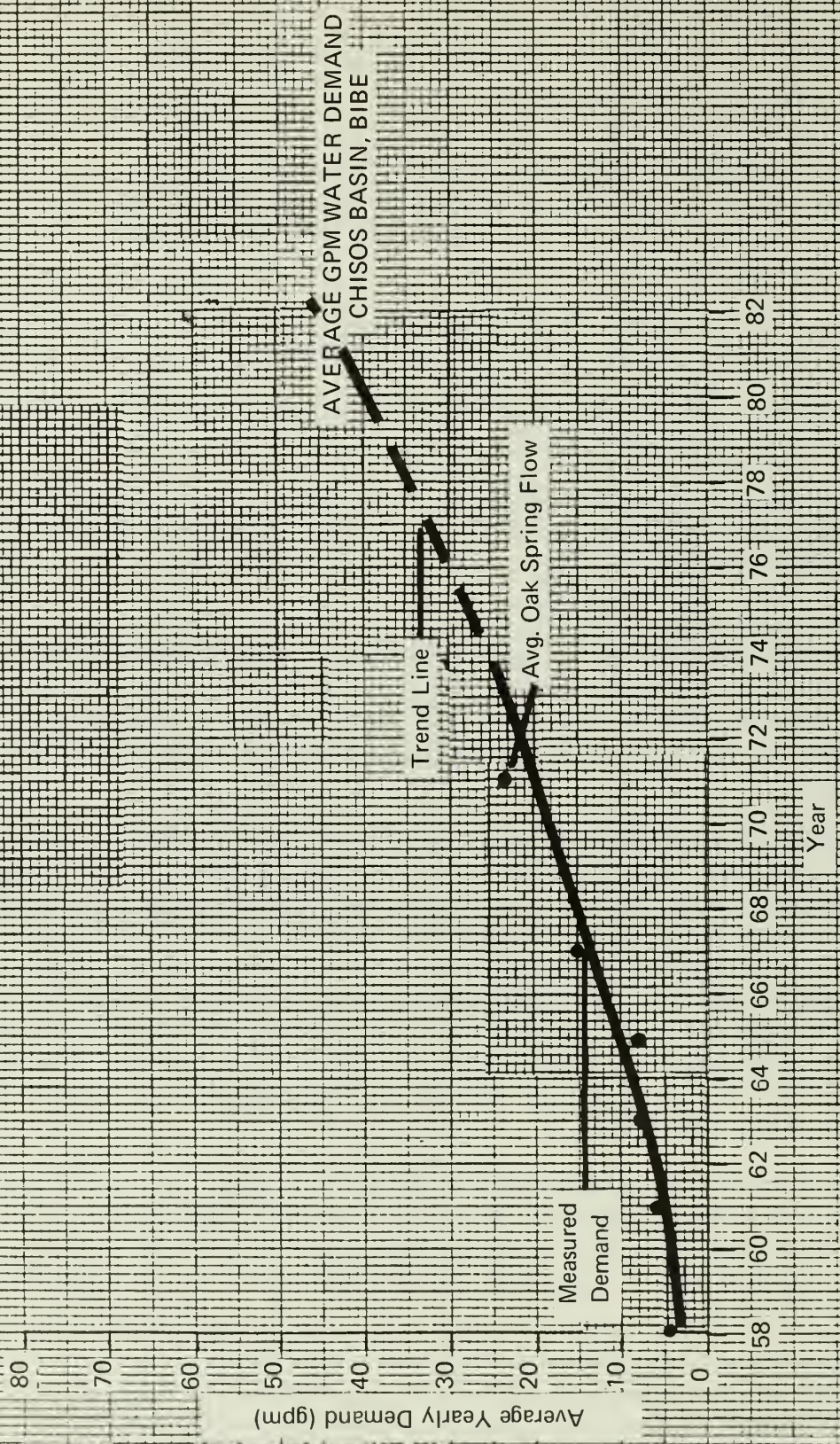


Figure 11

VEGETATION

The vegetation of Chisos Basin has felt the impact of man's presence since the 1800's. In the 1930's, the Civilian Conservation Corps constructed extensive roads and trails and the stone/adobe cottages in the upper basin, causing complete removal of vegetation, shifting of soils, soil erosion, and alteration of drainage patterns. The eroded or denuded areas permitted the introduction of invading vegetation.

The basin was not overgrazed by ranchers from the 1880's to 1942. However, during 1942-44 — the interim between the cession of Big Bend lands by the State of Texas and the creation of the national park — free grazing permits were granted, and portions of the basin were heavily overgrazed. These areas had not yet recovered in 1970 after a period of 28 years (Whitson 1970).

The operation of NPS and concessioner facilities, especially the saddle-horse concession, has had additional negative effects on vegetation, particularly around the developed area and along the trails. The overall effect of man's presence has been to permit the maintenance of more xeric (desert) vegetation at the expense of the recovery of the original deciduous and evergreen woodland vegetation, which is unique to the basin.

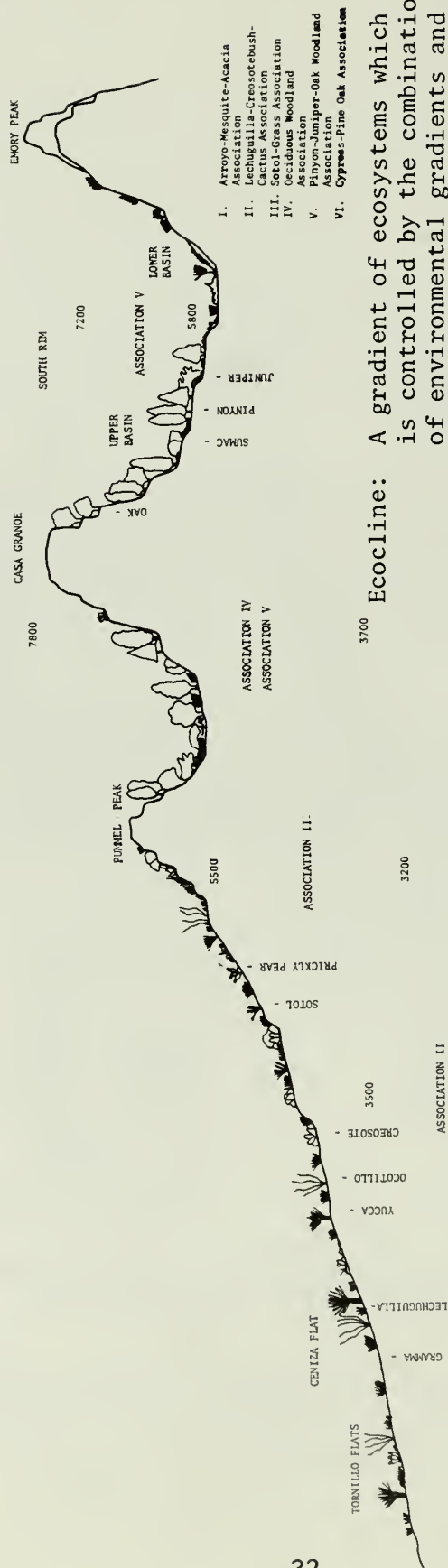
Chisos Basin vegetation is not only unique in kind, but also in distribution and variety. Three plant associations are found in the basin: Sotol/Grass Association, Deciduous Woodland Association, and Pinyon/Juniper/Oak Woodland Association (Wauer 1971, see appendix B). Of these, the Pinyon/Juniper/Oak Woodland Association is most prevalent. The following important species of this association can be found in the basin (Warnock 1970):

Gray oak	<i>Quercus grisea</i>
Chisos red oak	<i>Quercus gravesii</i>
Emory oak	<i>Quercus emoryii</i>
Gambel oak	<i>Quercus gambelii</i>
Alligator juniper	<i>Juniperus deppeans</i>
One-seed juniper	<i>Juniperus pinchotii</i>
Drooping juniper	<i>Juniperus flaccida</i>
Pinyon pine	<i>Pinus cembroides</i>
Big tooth maple	<i>acer grandidentatum</i>

The unique woodland species inhabiting the basin is the drooping juniper, which grows in the United States only in the Chisos Mountains (Warnock 1970).

Forestation is limited to the high slopes of the rims and the northern slopes, where trees are afforded either shade from the intensity of the solar radiation or increased rainfall, or both. The vegetation on the southern slopes is typical of vegetative types found on the alluvium fans around the mountains.

ECOCLINE OF THE CHISOS MOUNTAINS



Ecocline:

A gradient of ecosystems which is controlled by the combination of environmental gradients and community gradients; that is as one moves up from the Chihuahuan Desert floor of Tornillo Flats up through the heights of the Chisos, the ecological communities increase in diversity, productivity and size.

Figure 12

FAUNA

Birds

Thirty-two species of birds inhabit the Pinyon/Juniper/Oak Association within the park. Forty-two species (not all different from those in the Pinyon/Juniper/Oak Association) inhabit the Deciduous Woodland Association. Of these species, three limit their activities exclusively to the Pinyon/Juniper/Oak Association: the golden eagle, Rivoli's hummingbird, and the Hepatic tanager (Wauer 1971). There are regularly two nests of golden eagles near the basin lodge (Wauer 1973). Six other species – the zone-tailed hawk, phainopepla, black-capped vireo, blue grosbeak, and varied bunting – nest only in the Deciduous Woodland Association (Wauer 1971). A list of those species of birds found in the Chisos Basin, with notations as to their probable adaptation to human development, is included in appendix B.

Reptiles and Amphibians

Four species of lizards, including the Texas alligator lizard found only in Big Bend country, depend upon the plant associations in the basin area. No poisonous lizards are found in the park. The six species of snakes found in this area include two poisonous snakes – the western diamondback rattlesnake and the black-tailed rattlesnake. No terrapins are native to the basin area.

A listing of basin reptiles and amphibians is included in appendix B.

Mammals

A variety of mammals inhabit the Chisos Basin area (see appendix B). Included are two species each of rats and rabbits, three species each of bats and skunks, and one species each of mice and fox. Ringtails and bobcats are also common in the area. The most unusual mammal in the basin is the Carmen whitetail deer, which is found nowhere else in the United States. The mammalian population is increasing according to observations by Warnock and the local ranchers, but no long-term wildlife counts from this area exist to corroborate their observations. The increase is believed to be the result of game protection, removal of the livestock competitors, and recovery of plant habitats.

ARCHEOLOGICAL AND HISTORICAL RESOURCES

When Caveza de Vaca visited the Big Bend area in the 1530's, he found Indians inhabiting the area. These early inhabitants of Big Bend have been called Big Bend Basket Makers. The relationship between this early Indian culture and later ones is not clear. Various branches of the Apache tribe and a group known as the Chisos tribe were in the area in the 17th century (Maxwell 1971). Until the late 1800's, the Comanches and Apaches actively raided settlements in and around Big Bend, discouraging white

settlement. However, in the early 1900's, trading posts were established. Dealing in furs and special trade goods, the trading posts were an important part of the economy of the Big Bend region.

Important archeological, paleontological, and historical sites, reflecting the colorful history of the area, exist in other parts of the park. An archeological survey was made of the park in 1966-67 by T. N. Campbell. No significant sites were found in the Chisos Basin. No sites that have been nominated to or are on the National Register of Historic Places are located in the Chisos Basin area (see appendix A).

Campbell's work was conducted mainly outside of Chisos Basin. Until an intensive survey is made specifically on Chisos Basin, the above statement about no significant sites must be qualified. Detailed archeological surveys will be conducted on any potential construction sites to avoid the inadvertent destruction of archeological resources. At the present time, however, no undisturbed areas are proposed for new development in any of the alternatives presented.

POLLUTION

Raw sewage from the facilities at the basin presently flows through pipes to two sewage lagoons, where the natural processes of settling, evaporation, and oxidation act upon the effluent. The lagoons are protected from storm runoff by their location and dikes. During the torrential rains that occur a few times a year, the two lagoons may overflow into Oak Creek, an intermittent stream that flows through the Window and down to the Oak Springs drainage area, below. The drainage area is lower in elevation than Oak Springs, which is lower in elevation than Oak Creek in the basin. Therefore, any contamination of the springs would only be possible if there were fissures crossing the Oak Creek streambed in Chisos Basin. No hydrological or geological studies have demonstrated the presence of any fissures.

It is estimated that some 100,000 automobiles, light trucks, and campers visit the basin yearly. While the basin does have good air movement most of the time, the very shape of the area and the limited openings (the Window and Panther Pass) increase the possibility of a thermal inversion and the concentration of automobile exhaust during certain climatic conditions.

Noise from trucks, campers, and automobiles entering and leaving the park area, especially on steep grades, may be a nuisance to some park visitors, particularly sleeping campers.

The scenic vistas in the basin are many and varied, and they are an important natural resource (see figure 2). The visual clutter and deteriorated structures now present in the basin tend to detract from scenic beauty.

LAND USES SURROUNDING THE PARK

Urban land uses occur in the small towns and villages on the fringes of the park.

Hunting is permitted on private lands and the Black Gap Game Management Area of the State of Texas during season. At times hunters may stray into the wilderness areas of the park.

Ranching occurs on lands adjacent to the park. Cattle, sheep, and goats occasionally stray into nearby areas of Big Bend.

Mines in the area once produced a variety of metal ores: gold, silver, and cinnabar. Presently only cinnabar is mined in limited quantities. Total mineral value of the county for 1972-73 was placed at \$243,000 (Texas Almanac).

Population Centers

Big Bend National Park is relatively isolated from adjacent communities, with the exception of Study Butte, a little mercury-mining village of about 30 persons located at the park's northwest entrance. The largest towns containing reasonable shopping facilities are Alpine (1970 population 6,232), 100 miles distant from park headquarters at Panther Junction; Fort Stockton (8,242), 137 miles; and Odessa (78,380), 222 miles. El Paso (322,261), the largest city within the Trans-Pecos area of Texas, is 320 miles to the northwest.

Socioeconomic Environment in the Park Vicinity

The 1972-73 Texas Almanac includes the following data on Brewster County: The population was 7,780 in 1970. The economic base is agriculture and business. Cattle, sheep, and goat ranching bring over \$3 million average income. There are no significant crops. The chief economic factors are ranching services, tourist trade, hunting licenses, and Sul Ross State University. The 1970 U.S. Census states that 2,822 of the 7,780 total population are employed. The park is regularly staffed by 39 National Park Service employees, a figure that may reach 82 seasonally. National Park Concessions, Inc., the general concessioner, employs 55 persons regularly, a figure that rises to 65 seasonally. Chisos Remuda, the horse concessioner, employs 4 persons regularly, the total rising to 7 seasonally. The maximum of 154 possible employees in the park represents 5.4 percent of the county's total employment.

Of the total county population, 3,717 have Spanish as their first language. Income per capita is low. More than 39 percent of the individuals and 30.3 percent of the families are classified below the poverty level. This figure is 39.4 percent for the Spanish

TABLE 4

General Regional Social and Economic Characteristics
(From Bureau of the Census 1970)

Information	Brewster	Jeff Davis	Pecos	Presidio	Terrell
Population	7,780	1,363	13,748	4,842	1,916
% rural*					
nonfarm	19.8	93.9	33.3	36.9	95.0
% rural					
farm	1.4	14.9	6.7	6.3	9.6
Median					
income (\$)	5,643	5,590	8,003	4,189	6,577
Per capita					
income (\$)	1,995	1,893	2,383	1,723	2,169
% of all families					
with income less					
than poverty level	27.1	26.5	15.1	40.9	23.6
% of all persons					
with income less					
than poverty level	34.7	31.3	18.9	50.3	23.9
Total employed	2,822	593	4,924	1,471	637
% in manufacturing					
industries	2.3	—	5.3	9.1	0.8
% in white collar					
occupations	48.1	35.9	36.7	44.3	35.5
% government					
workers	32.3	39.3	10.8	21.0	13.7

*"Rural" is defined as those places not classified as urban. "Urban" may be defined as those places in which more than 2,500 persons live. The rural population is subdivided into the rural farm and rural nonfarm populations. The farm population consists of persons living on places of 10 acres or more from which sales of farm products amounted to \$50 or more in the preceding calendar year or on places of less than 10 acres from which sales of farm products amounted to \$250 or more in the preceding year.

surname portion of the population. The median school years completed by county males is 12 years; by females, 11.7 years. Calculations include approximately 2,500 students in Sul Ross State University. High school graduates total 50.8 percent of the males and 52.3 percent of the females.

Table 5 indicates modest growth in trade and services in Brewster County since 1958.

Hunting also attracts seasonal visitors, and hunting leases are a source of income for some persons.

Several small American and Mexican settlements exist on the edges of the park — Terlingua and Study Butte to the west, and Santa Elena and Boquillas across the Rio Grande in Mexico. Terlingua is also the base for land sales for “ranchettes” along the northwestern edge of the park, as well as for the Terlingua Chili Cook-off.

The National Park Concessions, Inc., store at Castolon serves Terlingua, Study Butte, and Santa Elena for convenience items. The National Park Concessions, Inc., store at Rio Grande Village serves Boquillas. Major purchases are secured at Alpine or more distant towns and cities.

VISITOR PROFILE ANALYSIS

Visitation Records

The National Park Service estimated 341,000 visitors to Big Bend National Park in 1973.

TABLE 5

Brewster County

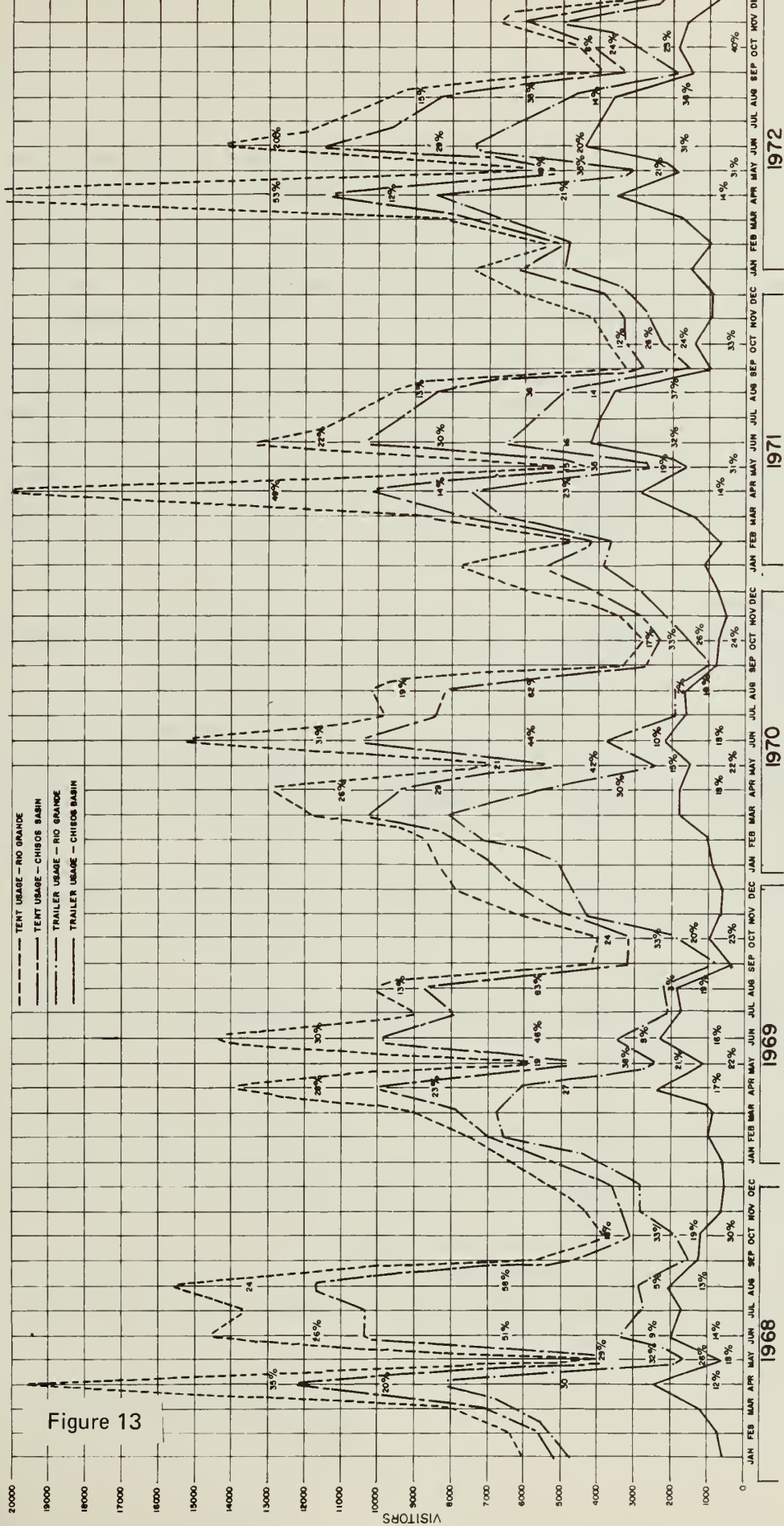
Sales: 1958, 1963, 1967
 (From 1972 Regional Data Book, West Texas Council
 of Governments, El Paso, Texas)

	Year			Percent Change	
	1958 (\$1000)	1963 (\$1000)	1967 (\$1000)	58-63	58-67
Total sales, retail trade	7151	8383	9970	+17.2	+ 39.4
Sales, eating, drinking places	398	550	1144	+38.2	+187.4
Sales, food stores	1469	1999	2515	+36.1	+171.2
Total sales, selected services	998	966	1704	- 3.2	+ 70.7

TABLE 6

Visitation, Big Bend National Park

Year	Number of Visitors	
1963	114,232	
1964	119,698	
1965	174,566	
1966	163,548	
1967	173,290	General Trend
1968	191,764	
1969	199,805	
1970	172,648	
1971	247,401	
1972	290,247	
1973	341,200	Upward



Visitor Usage

155 | 40,011
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United States Department of the Interior
National Park Service

Overnight visitors to the park are presently accommodated in tent and trailer campgrounds in Chisos Basin, Castolon, Rio Grande Village, and Panther Junction; and in motel-type accommodations provided by National Park Concessions, Inc., in Chisos Basin only. General park use by campers with tents or trailers is illustrated in figure 13. The number of trailer campers may continue to increase due to greater amounts of vacation time, increasing costs of motel and hotel rental, and the sophistication of trailer and camper technology. The total trailer hook-up rental figure (January through October 1972) for Panther Junction and Rio Grande Village was 16,209. Peak use of the park occurs from early spring (Easter season), when the desert is in bloom, to late August, with minor fluctuations occurring during the summer months. June is the peak month of vacation time. It should be noted that visitation is high at Rio Grande Village even during some of the hottest months of the year and when the insect population is at its peak.

Visitor Characteristics

Visitors who come in winter tend to rent rooms or tow trailers. They are for the most part older retired and/or affluent people who have longer periods to travel.

Visitors who come in summer tend to camp in tents or trailers. They are younger, and they have more restricted travel schedules because of work, school, size of family, and income. The younger users begin to arrive during the peak in April (Easter vacation) and have left the park by the end of summer (before school starts).

During the spring and summer, rooms are seldom available except on a reservation basis. This situation also occurs, but less frequently, in the fall and winter.

A natural or semi-wilderness park attracts primarily those people who are willing to rough it. The very ruggedness of the country precludes any "boardwalk" group except in the upper Chisos Basin lodge area.

Visitor Use

Activities available to the visitor are sightseeing, hiking, horseback riding, camping, fishing, and canyon float trips. For those who are interested, there is also the opportunity to explore and study the many and varied resources.

Visitor use of Chisos Basin has been generally increasing. However, the nationwide energy crisis of late-1973/early-1974 reversed this upward trend and has made uncertain a continuing increasing use of the basin.

TABLE 7

Chisos Basin Travel and Use

	Total Park Visits	Chisos Basin Visits	Chisos Basin Lodge	Chisos Basin Campgrounds
1974				
June	22,141	11,104	4,232	6,585
May	16,832	10,456	3,498	4,130
April	25,249	12,413	4,062	6,782
March	14,643	7,077	2,276	3,628
February	10,297	4,719	1,403	1,692
January	11,480	6,404	2,141	2,861
Totals	100,642	52,173 51.8%*	17,612 33.8%**	25,678 49.2%**
1973				
December	11,665	5,482	1,746	1,743
November	23,881	10,252	3,508	3,404
October	29,628	8,861	3,608	2,629
September	27,293	7,405	3,288	2,817
August	28,144	12,908	4,469	6,103
July	28,178	13,025	4,605	6,476
June	33,961	14,848	4,719	5,449
May	27,286	11,812	3,723	3,978
April	47,684	23,773	4,248	4,405
March	40,197	10,238	3,154	3,563
February	22,022	4,831	2,609	1,185
January	21,333	8,739	2,663	2,948
Totals	341,272	132,174 38.7%*	42,340 32.0%**	44,700 33.8%**

* percent of total visits

** percent of Chisos Basin visits

	Total Park Visits	Chisos Basin Visits	Chisos Basin Lodge	Chisos Basin Campgrounds
1972				
December	16,989	6,489	1,813	1,238
November	24,192	5,845	3,128	3,094
October	20,216	9,448	3,559	3,106
September	20,500	9,919	3,423	2,801
August	27,377	15,065	4,777	7,508
July	28,213	15,662	4,822	7,999
June	32,403	12,852	4,816	9,276
May	21,396	6,652	3,818	4,511
April	40,782	23,207	4,240	7,259
March	21,696	12,438	3,235	2,847
February	18,134	9,737	2,673	1,373
January	18,347	11,607	3,254	3,352
Totals	290,545	138,921 47.8%*	43,558 31.4%**	54,364 39.1%**

1971				
December	14,585	5,477	2,167	1,808
November	18,935	2,738 (?)	2,994	1,897
October	22,799	8,230	3,327	2,495
September	14,833	9,001	3,093	2,502
August	21,182	15,596	4,807	7,589
July	23,975	17,202	4,710	8,221
June	26,876	19,434	4,797	9,139
May	16,765	13,112	3,869	3,719
April	35,658	10,091	4,063	6,355
March	18,337	7,874	2,801	2,747
February	16,303	6,765	2,587	1,190
January	17,153	8,978	2,763	2,952
Totals	230,248	124,498 54.1%*	41,978 33.8%**	50,594 40.6%**

* percent of total visits

** percent of Chisos Basin visits

	Total Park Visits	Chisos Basin Visits	Chisos Basin Lodge	Chisos Basin Campgrounds
1970				
December	12,078	7,874	2,293	1,898
November	8,344	7,839	2,901	1,141
October	9,856	9,565	3,392	1,600
September	10,738	12,118	3,284	2,533
August	15,768	20,824	4,877	8,303
July	16,716	12,604	4,443	8,060
June	17,349	18,511	4,656	8,631
May	10,745	12,033	3,463	4,239
April	24,818	20,672	3,917	4,766
March	17,371	9,979	2,861	3,400
February	14,532	5,672	2,236	1,625
January	14,333	6,733	2,564	2,124
Totals	172,648	144,424	40,887	48,320
		83.7%*	28.3%**	33.5%**

* percent of total visits

** percent of Chisos Basin visits

TABLE 8

Travel Trends

Total Park Visitors		June 1970	17,349
		June 1971	26,876
		June 1972	32,403
	DOWN	June 1973	33,961
		June 1974	22,141
Chisos Basin Traffic (Cars)		June 1970	18,511
		June 1971	19,434
		June 1972	12,852
	DOWN	June 1973	14,848
		June 1974	11,104
Chisos Basin Lodge (House Count)		June 1970	4,656
		June 1971	4,797
		June 1972	4,816
	DOWN	June 1973	4,719
		June 1974	4,232
Chisos Basin Campground (Campground Count)		June 1970	8,631
		June 1971	9,139
		June 1972	9,276
	UP	June 1973	5,549
		June 1974	6,585

The decreases registered for June 1974 in general park travel, traffic to the Chisos Basin, and the house count at the Chisos Basin lodge can be directly attributed to the late 1973-74 energy crisis, which resulted in rather severe decreases in automobile travel to remote parks like Big Bend. This generally lower level of travel is expected to continue. No valid prediction of future travel can be made because the energy situation is uncertain.

An explanation for the increase in campground use during this same period is that people are seeking less expensive methods of travel, and once they get to the park, they are staying longer.



legend:

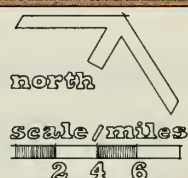
land classification

-  class two
-  class three
-  class four
-  class five
-  class six

special resources

-  chisos basin
-  cattail falls
-  boot canyon
-  pine canyon
-  burro mesa
-  trans-pecos cave swallow
-  endangered chihuahuan shiner
-  lance-leaved cottonwood
-  mosquito fish

land classification



155 | 20013
May 73 | DSC

United States Department of the Interior
National Park Service

figure 14

alternatives

	A	B	C	D	E
lodge units	REPLACE	REMOVE FROM BASIN	REPLACE	INCREASE	REPLACE
remuda	MAINTAIN	REMOVE FROM BASIN	REMOVE FROM BASIN	REMOVE FROM BASIN	MAINTAIN
campgrounds	MAINTAIN	REMOVE FROM BASIN	MAINTAIN	INCREASE	DECREASE
picnic grounds	MAINTAIN	MAINTAIN	MAINTAIN	MAINTAIN	MAINTAIN
roads & parking	MAINTAIN	REMOVE FROM BASIN	REMOVE FROM BASIN	REMOVE FROM BASIN	DECREASE
employee housing	REPLACE	REMOVE FROM BASIN	RELOCATE WITHIN BASIN	RELOCATE WITHIN BASIN	DECREASE
maintenance facilities (concession)	REPLACE	REMOVE FROM BASIN	RELOCATE WITHIN BASIN	RELOCATE WITHIN BASIN	MAINTAIN
utilities	REPLACE	REMOVE FROM BASIN	REPLACE	REPLACE	REPLACE

chisos basin development concept alternatives

155 | 40.017
NOV 74 | OSC

United States Department of the Interior
National Park Service

figure 15

ALTERNATIVES

ALTERNATIVE A: NO ACTION

This alternative would maintain the general status quo on visitor activities and concession/NPS operations in the basin. Normal maintenance of all facilities would continue, and obsolete facilities would be replaced on their original sites on a one-to-one basis. In addition, campsites would be "rested" on a rotating basis, as prescribed by good management criteria, and foot and horse trails would be relocated for safety reasons. The projected sewage-treatment plant would also be constructed, as the facilities now used for sewage-treatment are no longer adequate under current Texas State Health Department standards.

Impacts

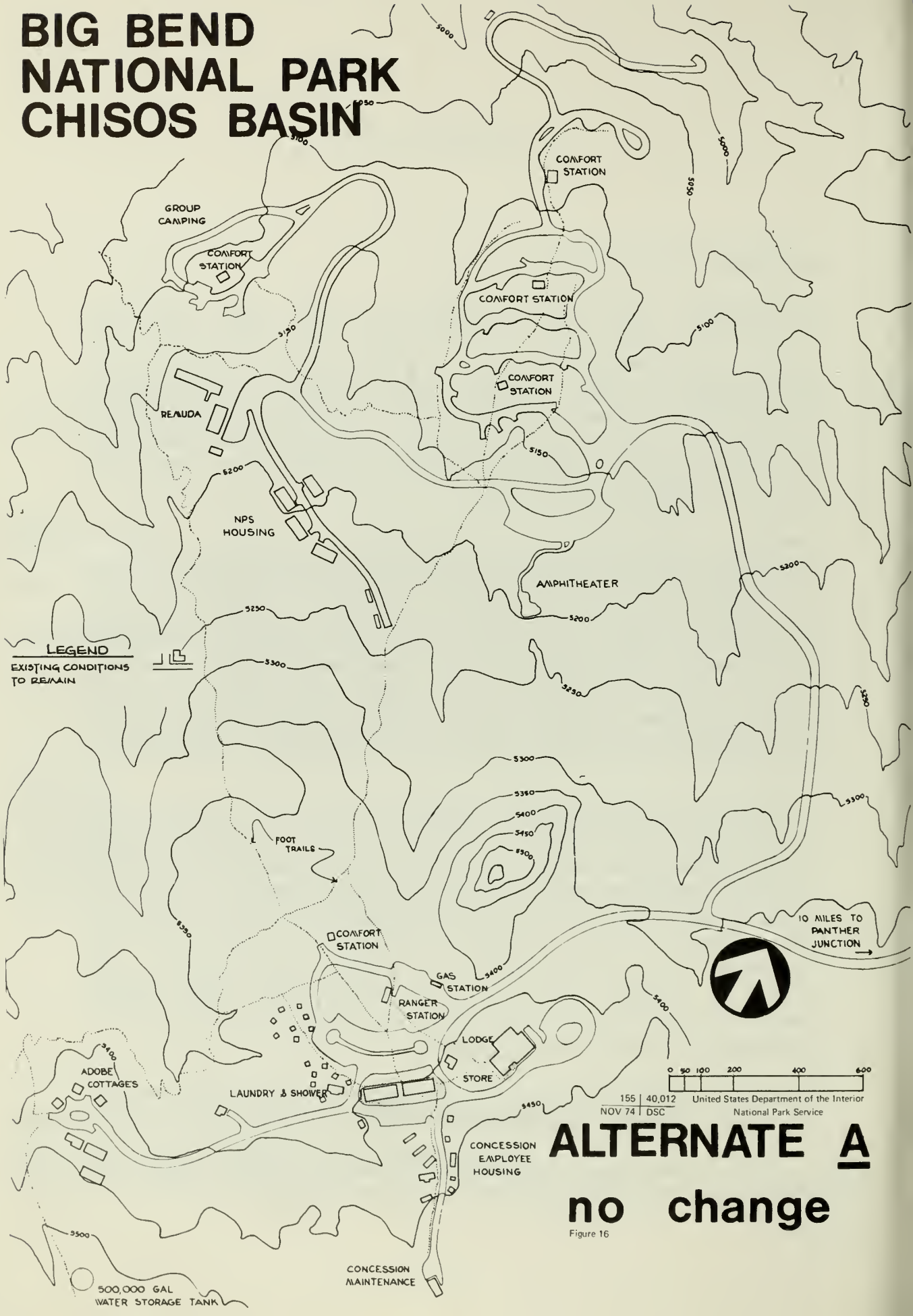
Until marginal facilities were replaced, they would be increasingly difficult to maintain at an acceptable, safe standard. The cost of maintaining the 25-year-old poorly constructed Dallas huts at a safe standard would be high and probably not worth the expended time or money. Also, until they were replaced, their rundown condition would continue to be a particularly objectionable visual intrusion in the basin. However, as long as the Dallas huts were maintained, new construction could be avoided, therefore no new short-term environmental impacts would occur in the basin, and no new expenditures would be required of the concessioner or the National Park Service.

Visitor services would eventually be improved as both visitor accommodations and support facilities were replaced on a one-to-one basis. The visitor's immediate surroundings would become more pleasant, and services provided for him would probably also improve as a result of a more attractive living environment for concession personnel. Replacing facilities on a one-to-one basis would solve many of the problems of maintaining and living in the present structures, but it would not rectify their inappropriate and poor siting arrangement. The facilities would remain as a visual intrusion on otherwise expansive scenic vistas. Also, minor conflicts between employees and visitors would continue because the employee housing would still be in close proximity to the visitor accommodations.

Construction activities to replace the Dallas huts might have a detrimental effect on the golden eagles that have been sited nesting near the lodge.

Under the no-action alternative, human activities and the facilities that support them would continue to significantly disturb the natural environment.

BIG BEND NATIONAL PARK CHISOS BASIN



ALTERNATE A

no change

Figure 16

Walks and parking spaces would still be unconfined around employee housing, and residents would continue to trample and drive over vegetation throughout the housing area. Very little vegetation remains there now, and erosion is uncontrolled in the vicinity of the residences.

Horseback riding in Chisos Basin would continue to be available for those who enjoy it. However, maintaining 20 to 60 saddle horses in the remuda corral would continue to result in severe trampling, horse odors, pest concentrations, and accumulations of fecal material there. Water consumption by the horses would undoubtedly continue at its present rate. Trampling of vegetation and erosion would also continue along the horse trails. In addition, grasses and other vegetation that are not native to the basin would continue to be spread through seeds in fecal material dropped by horses along the trails.

The Carmen whitetail deer and other wild animals that make the basin their home would continue to benefit from consumption of some of the feed that is provided for the horses. However, artificially maintaining the deer population at a higher than normal level is ecologically unsound.

Expanses of paved roads and parking lots would continue to provide convenient access for visitors traveling in cars and recreational vehicles. However, these facilities would also continue to disrupt natural drainage patterns. Also concomitant with the present level of automobile traffic are air pollution and noise and the visual impact caused by the presence of cars, roads, and parking areas. At last count, there were 223 parking spaces in the upper basin and 147 spaces in the lower basin. A conservative estimate of paving required for the 370 parking spaces is 166,500 square feet, or almost four acres. Oils and fuels that do not evaporate after being dropped by motor vehicles eventually find their way into drainages or onto road shoulders, causing some degradation of native resources.

Because of some relatively steep grades on the road system, and several tight hairpin turns on the basin approach road, visitors' cars can overheat, and the potential for automobile accidents is increased. Visitors enjoy several spectacular vistas of the basin and mountain ranges from the road, but such enjoyment can become hazardous if it distracts the driver's attention. Under the no-action alternative the advantages and disadvantages of the road system would remain unchanged.

The no-action alternative would not affect camping in the basin. The campground, with its 71 family campsites and 3 group campsites, is also an intrusion on the landscape. The campground was developed on a gently sloping hillside, which required some cutting and filling to create usable camping spaces and parking areas. An amphitheater is located adjacent to the campground. It also has a parking area for those unable to walk from their campsites and for those visitors staying at the lodge in the upper basin. Visitor use has degraded the area considerably. Erosion of fill-slopes and the scattering of litter are constant problems. Foot traffic between campsites and to the comfort stations makes revegetation all but impossible in these areas. And

inasmuch as most campers have a full array of cooking, lighting, and heating equipment, the resultant air pollution is often apparent.

In spite of the condition of the campground, visitors find the experience of camping in the basin a very relaxed and rewarding one. More than 6,500 camper-visits were recorded as of June 1974, compared to slightly more than 5,500 visits as of June 1973.

Day-use facilities, including picnic grounds, are minor in the basin due to its great distance from any sizeable population centers. In the lower basin, picnickers may use the tables, fireplaces, trash containers, and parking sites at the campground, if they are available. In the upper basin, a modest picnicking facility is located to the west of the ranger/contact station. The impacts of picnicking are similar to those of camping, only on a much smaller scale, and they would not be affected by the no-action alternative.

The projected sewage-treatment plant would discharge a maximum flow of 42,000 gallons per day in both wet and dry seasons. This is approximately twice the average flow now generated. The effluent would flow to, and remain in, the present stabilization ponds (nominal capacity 1,522,000 gallons) for further treatment following extended aeration. Evaporation resulting from the extended-aeration process would be greater, making humidity somewhat higher than it is now. The sewage-effluent stabilization ponds are protected from storm runoff by their locations and dikes. The rate of evaporation is quick in this area, but the ponds would still possibly overflow during the peak visitation months and following occasional torrential rains. Under normal conditions, Oak Creek Canyon is dry, and the small quantity of water discharged from the stabilization ponds usually evaporates quickly and doesn't flow very far. It is anticipated that the chlorinated effluent would also disappear before traveling very far. There would be practically no potential for alteration of animal habitats by this chlorinated effluent because it would be diluted in the stabilization ponds, and because its residual level of chlorine would be only 1.0 milligram per liter after 20 minutes contact. If contact time were shortened, chlorination levels in the discharge would likely remain negligible.

LP gas would continue to be the energy source for the two motel units, the central bath and laundry, and the restaurant and lodge. The storage facility is located where it is practically unnoticeable to visitors, but the units and the fence could be painted to be more esthetically pleasing. This would have to be within design code. The truck that fills the tanks destroys vegetation along the approach to the enclosure. Occasional spillage of liquid fuel might also damage vegetation, although the fuel vaporizes rapidly. LP gas is an economical source of heat for the concessioner's operation, and it gives him a dependable source of energy during power outages.

Overhead power and telephone lines would continue to create a visual intrusion in the basin. Some minor disturbance of vegetation occurs whenever these lines are serviced.

The success of operating Chisos Basin on a status quo basis would depend on the availability of the vital resource – water. The development in the basin presently diverts a varying amount of water from Oak Springs, depending on the season and the number of facilities in operation. Currently, water used at the overnight accommodations amounts to 8,220 gallons per day (see table 4). Assuming that visitation did not increase considerably, the no-action alternative would not place unrealistic demands on the available water supply, except perhaps during conditions of drought. No studies have been undertaken to address the effects that would result from diverting too much water from Oak Springs, but reduced stream flows would undoubtedly impact invertebrate animals in the stream and might possibly have farther-reaching impacts.

Mitigating Measures

Measures to mitigate the impacts of maintaining the status quo are inherent in normal day-to-day maintenance and replacement of facilities, and include maintaining a high standard of cleanup and maintenance for buildings, trails, and roads; landscaping eroded and impacted road shoulders, campgrounds, and picnic areas; implementing safety measures in hazardous areas and structures; removing exotic plants introduced through imported fill material and horse manure dropped along trails; and conserving water and energy used in the basin's lodge units, employee housing, campground, and other developments.

Adverse Effects

Implementation of alternative A would have the following unavoidable adverse effects:

Such visitor activities as camping, trail riding, and driving in the basin would continue to significantly impact this outstanding natural area.

Inappropriately sited facilities for the accommodation and support of visitor use would continue to disrupt what could otherwise be expansive scenic vistas.

Short-Term/Long-Term Relationships

There would be no short-term disruption of visitor services providing the water supply remained adequate.

As the Dallas huts outlived their usefulness and the cost of repairing them became excessive, the apparent benefits of pursuing that course of action would prove to be false and not in the interest of the visitor or the concessioner.

Degradation of the environment would some day reach the point that the basin would no longer be attractive to the public. Plants and animals might withdraw to more remote areas of the Chisos Mountains.

Irreversible and Irretrievable Commitments of Resources

This alternative would commit the basin's natural resources to supporting existing levels and kinds of recreational use and development. To maintain this level of activity, water from Oak Springs, and during periods of extreme drought, water from the infiltration gallery in the streambed below Cattail Falls, would be irretrievably diverted from the hydrologic cycle. Environmental degradation caused by visitor activities and facilities for their support, although significant, would probably not be irreversible, but the restoration process would be slow and costly.

ALTERNATIVE B: PHASE OUT ALL DEVELOPMENT EXCEPT FOR DAY-USE FACILITIES; DEVELOP PUBLIC TRANSPORTATION TO REPLACE AUTOMOBILE ACCESS

Under this alternative, the campground, overnight accommodations, remuda, employee residences, maintenance facilities, utilities, and most roads and parking areas would be removed from Chisos Basin. A transportation system would be developed to bring visitors into the basin, perhaps using buses or mini-trains, and automobiles would no longer be allowed in the area. Only dining and restroom facilities and the roads and parking areas necessary to support the transportation system would remain. The road system would be reduced to less than half its present extent, and considerable developed acreage would be returned to its natural state. Visitors could disperse from transit stops to take hikes, visit interpretive points, and dine.

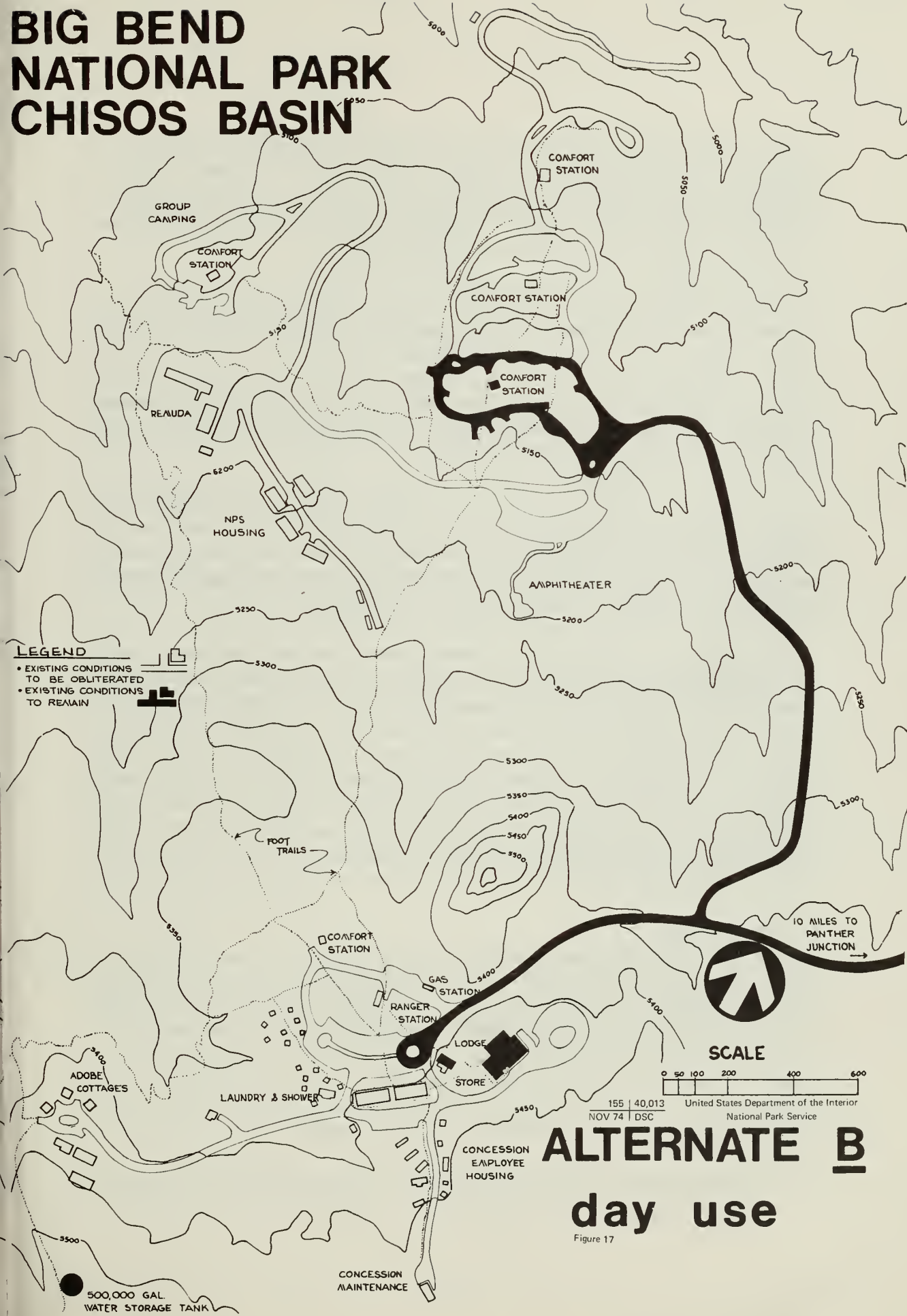
Impacts

The natural environment in Chisos Basin would be significantly improved by removing most of the facilities and activities that now degrade the resources and by revegetating approximately 50 acres with plants native to the basin woodland. The woodland could perhaps reestablish itself to its former extent, reversing the man-influenced encroachment of desert vegetation into the basin.

This alternative would reduce the consumption of water in the basin from the present average of 23,000 gallons per day to 8,000-10,000 gallons per day. Water available from Oak Springs and Cattail Creek would be sufficient to supply future day-use needs even if visitation increased, so the availability of water in the basin would be of less concern.

Although this alternative would benefit the natural environment in Chisos Basin, it might result in pressures and impacts on other environments in Big Bend. Alteration of the landscape and disruption of soils and vegetation would accompany the development of the transportation staging area at Panther Junction. Also, if the campground, overnight accommodations, residences, and maintenance facilities removed from the basin were replaced at some other park location, probably at

BIG BEND NATIONAL PARK CHISOS BASIN



Panther Junction, their construction and use would also impact the environment there. Because the resource values at Panther Junction are less important than the outstanding natural values in Chisos Basin, the net result would probably be ecologically beneficial. Total water consumption might be greater if facilities were relocated to Panther Junction because of a hotter climate.

If the campground and lodge facilities were relocated outside the basin, they could be replaced by upgraded facilities on possibly less land. The highest standards for water, sewage, telephone, and power systems could be followed, and all utilities could be placed underground unless otherwise prohibited by code. This alternative would provide an opportunity to provide the best services to the public, but the replacement of facilities that would be removed from the basin would be extremely costly, probably in the general range of \$8-10 million.

The facilities in the basin are used by many park visitors. If these facilities were removed and not replaced elsewhere in the park, visitors would have to start their tours of the basin from an overnight base about 100 miles away. The lack of overnight accommodations and campgrounds and other facilities might discourage visitation to Chisos Basin, and might even discourage visitation to Big Bend.

The experience that visitors have when they visit the basin would be greatly changed. They would only be able to enjoy the basin during the day, and then only when public transportation was available to take them there. Spending the night in the basin has been a popular and long-standing experience for many hundreds of thousands of visitors, which began even before the national park was established. Denying visitors this opportunity would deny them a park experience that is valid providing its impact on the environment remains at an acceptable level. However, in an environment relatively free from development, air pollution, noise, and traffic congestion, visitors would probably find such activities as hiking and exploring the natural features to be more enjoyable experiences.

Mitigating Measures

Visitors would be less inconvenienced by having to ride public transportation into the basin if the transportation system were efficient and pleasant and also served as an interpretive vehicle. The system could, in the future, be tied back to a public transportation system that would start from the visitor's home area, providing an alternative to using automobiles as the mode of travel to Big Bend National Park.

Adverse Effects

This alternative would have the following unavoidable adverse effects:

Denying visitors the traditional opportunity of staying overnight in Chisos Basin would be an adverse effect on many people.

Substantial economic expenditures would be needed to accomplish the removal and relocation of facilities. It is possible that lodge removal and replacement is not economically feasible for the concessioner. Also, if facilities were relocated, an area or areas outside Chisos Basin would be equally impacted to accommodate the facilities to be removed and replaced.

If overnight accommodations and campground units were not replaced within the park, many visitors would have to travel from an overnight base up to 100 miles distant from Chisos Basin if they were to visit that area.

Short-Term/Long-Term Relationships

This alternative would result in the greatest long-term benefit to the natural environment in Chisos Basin. If successful, it might even serve as a prototype for removing certain kinds of visitor uses from all of Big Bend, and for making greater use of public transportation systems to eliminate many of the adverse impacts associated with automobile travel.

Undertaking this alternative would result in a short-term disruption of travel to Chisos Basin during the transition period between automobile use and use of buses or mini-trains. The change of use-patterns in the park would be either a short-term or a long-term disruption, depending on whether or not the visitor accommodations removed from the basin were replaced nearby. Even if facilities were replaced, it is unlikely that public and private funding for this purpose could be obtained at one time to easily accomplish the transition between accommodating visitors in the basin and accommodating them in some other part of the park.

Irreversible and Irretrievable Commitments of Resources

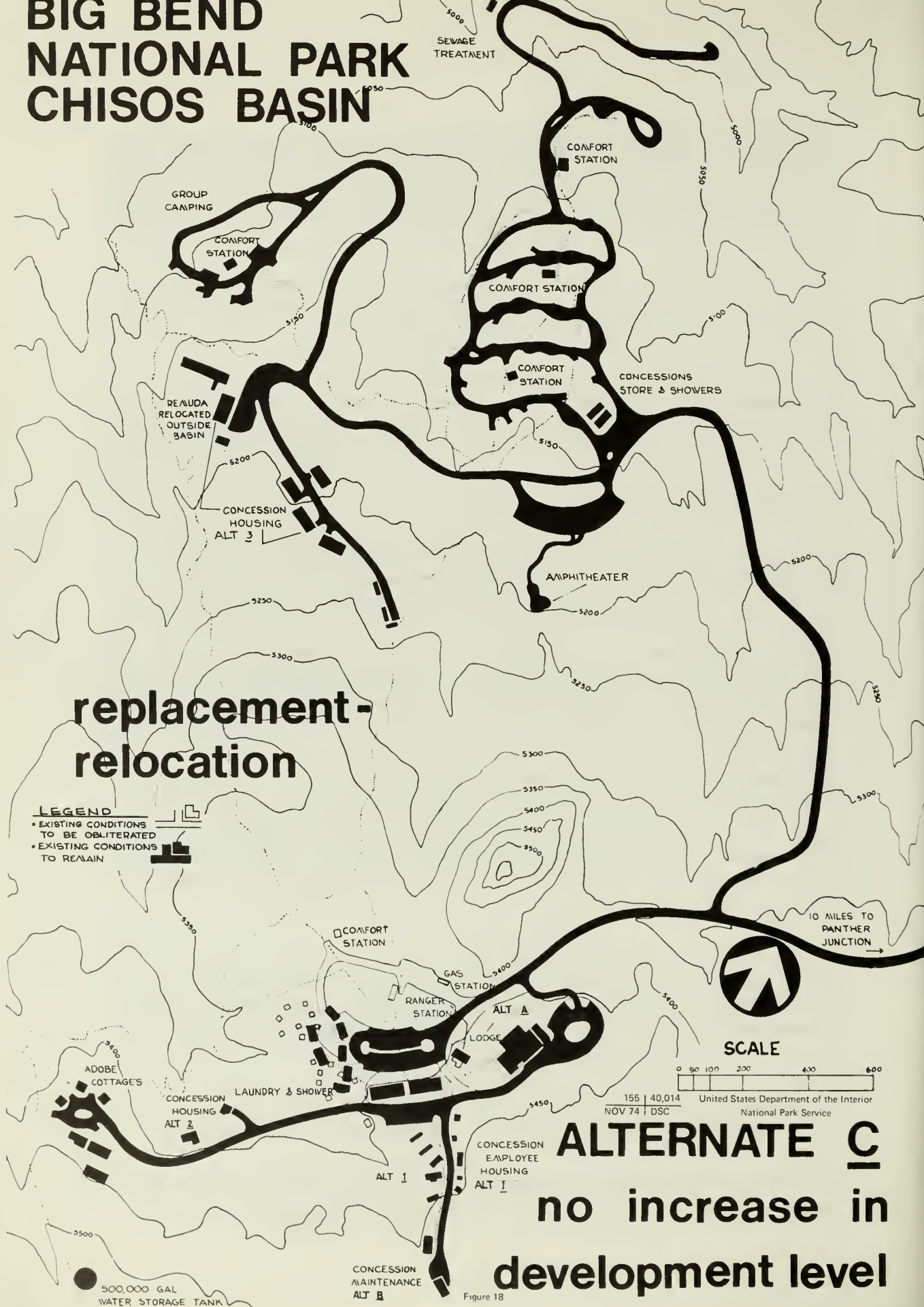
If this alternative were implemented, certain lands outside the basin would be committed to development. No irreversible effects on the environment would occur because at any time the landscape could be restored to its natural condition. The materials, labor, and time consumed in planning and implementing the project would be irretrievably committed.

ALTERNATIVE C: REMOVE SOME FACILITIES FROM THE BASIN AND RELOCATE OTHERS INSIDE THE BASIN; DEVELOP PUBLIC TRANSPORTATION TO EVENTUALLY REPLACE AUTOMOBILE ACCESS

Under this alternative, visitors would continue to be able to stay overnight in the basin. The campground would be maintained, and the Dallas huts would be replaced on the same site with an equal number of upgraded motel-type units.

The saddle-horse concession would be relocated to Panther Junction, and its present site would eventually be returned to its natural state.

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Employee residences, the concessioner maintenance facility, the NPS ranger/contact station, and the store concession would be relocated to other sites within the basin. Their present sites would be reclaimed as open spaces to optimize scenic viewing and the overall appearance of the development. Feasible sites for relocating employee housing are: their present general location in the upper basin, below the stone cottage road in the upper basin, and the site vacated by the remuda in the lower basin. The Maintenance facility would either be replaced in its present general location or attached to the lodge building.

The projected sewage-treatment plant would be constructed, and new underground utilities would be laid. Utilities no longer needed when buildings were relocated would be abandoned in place.

Some roads and parking areas would be abandoned and obliterated as the Chisos Basin development was restructured, and the gas station would be moved outside the basin. Eventually, a public-transportation system would be developed, and automobiles would no longer be allowed in the basin. At that time, only those roads and parking areas necessary to support the transportation system would remain. Lands no longer used for roads or parking would be reclaimed as open spaces.

Impacts

The new more functional arrangement of facilities should make the park visitor's experience more pleasant by opening up major scenic vistas and eliminating the existing clutter of deteriorated structures that has degraded the overall appearance of the basin. The visitor's experience should also be enhanced by providing him with new pleasant accommodations that are more comfortable and safer.

By removing the remuda, removing some roads and parking areas, and removing other facilities such as the gas station, and by placing all utilities underground, approximately 50 acres of impacted area in the basin could be reclaimed and restored to a natural condition. Conversely, the Panther Junction development area would be impacted by construction and use of the public transportation staging area and the horse concession.

There would be increasing reductions in traffic congestion and air pollution as automobiles were controlled and eventually barred. Some visitors might feel inconvenienced by these changes.

Water consumption would increase somewhat if this alternative were implemented. It has been estimated that 35 gallons per pillow per day are used in the Dallas huts (total

of 2,030 gallons per day), while 40 gallons per pillow per day would be used in the motel units (total 3,360 gallons per day). The total amount of water used in all the overnight accommodations would therefore increase from 7,590 gallons per day to 8,920 – an increase of approximately 17 percent. Oak Springs is a variable source of water, and the demands placed on that water supply might become excessive, especially during times of drought, if this alternative were implemented.

TABLE 9

**Estimated Water Consumption for Accommodations
under Alternative C**

Unit	Total Water Usage (gpd)
Motel	
41 units x 4 pillows/unit x 40 gallons/pillow/day	= 6,560
Cabins	
6 units x 6 pillows/unit x 40 gallons/pillow/day	= 1,440
Lodge	
7x3+1x2/pillows x 40 gallons/pillow/day	= 920
TOTAL	8,920

The proposed sewage-treatment plant would be able to handle increases in sewage generated by increased water consumption. The impacts of the sewage-treatment facility would be the same as discussed under alternative A.

Irrigation to establish lawns around the new motel units might affect surrounding vegetation, perhaps by stimulating and encouraging the invasion of exotic plants and certain native species. If foreign plant materials were stimulated, some effort might be required to remove them.

Construction activities to replace the Dallas huts might have a detrimental effect on the golden eagles that have been sited nesting near the lodge.

Mitigating Measures

Compliance with Executive Order 11593 has been accomplished in the master planning phase. Archeological survey, site evaluation, and data recovery, if appropriate, would take place at all construction sites before construction was initiated. Should sites be found to meet National Register criteria, both the State Historic Preservation Officer and the Advisory Council on Historic Preservation would be afforded the opportunity to comment.

An attempt to reestablish natural drainage patterns would be made. Erosion caused by present or proposed development would be corrected. Cuts would be covered with topsoil, revegetated with native woodland plants, and where possible irrigated for rapid recovery. The soils in the area proposed for construction of the motel units would be tested for bentonite content to ensure that the structures were not placed where the bentonite content is high enough to cause structural damage. To hold down dust and reduce the muddy conditions that would exist after construction of the motel units, the concessioner would grass and irrigate the lawn areas until they were established, which would take up to three years.

Mitigating measures to make public transportation attractive to visitors would be the same as those discussed under alternative B.

Unavoidable Adverse Effects

Implementation of this alternative would have the following significant unavoidable adverse effects:

The natural environment would be disturbed at construction sites, and noise and dust would be excessive during the construction period.

Some drainage and erosion problems might inadvertently be created.

Construction activities might have detrimental effects upon the golden eagles nesting near the lodge.

Continued and increased pressure upon the variable water supply might have detrimental hydrological and ecological effects, especially during periods of drought and heavy drawdown.

Short-Term/Long-Term Effects

Undertaking this alternative would result in a short-term disruption of travel to Chisos Basin during the transition period between automobile use and use of buses or mini-trains.

Development of the new motel units would enhance visual amenities and improve service to visitors, but at the same time, it would contribute to changing drainage patterns and vegetation in the basin.

Irreversible and Irretrievable Commitments of Resources

The materials, labor, and time consumed in planning and implementing the project would be irretrievably committed. No irreversible effects on the environment would occur because at any time the landscape could be restored to its natural condition.

ALTERNATIVE D: UPGRADE AND INCREASE THE NUMBER OF OVERNIGHT FACILITIES IN THE BASIN

Under this alternative, the 21 rental units in the Dallas huts would be replaced with up to 36 motel units on the same site. Twenty-two additional campsites would be added in the lower basin campground by increasing the density of campsites within the same area — perhaps by altering or eliminating the three group campsites. This increase in overnight facilities would permit approximately 180 additional people to stay overnight in the basin.

In all other respects, this alternative would be the same as alternative C.

Impacts

This alternative would have generally the same impacts on the natural and social environments as outlined under alternative C, with the exceptions discussed below.

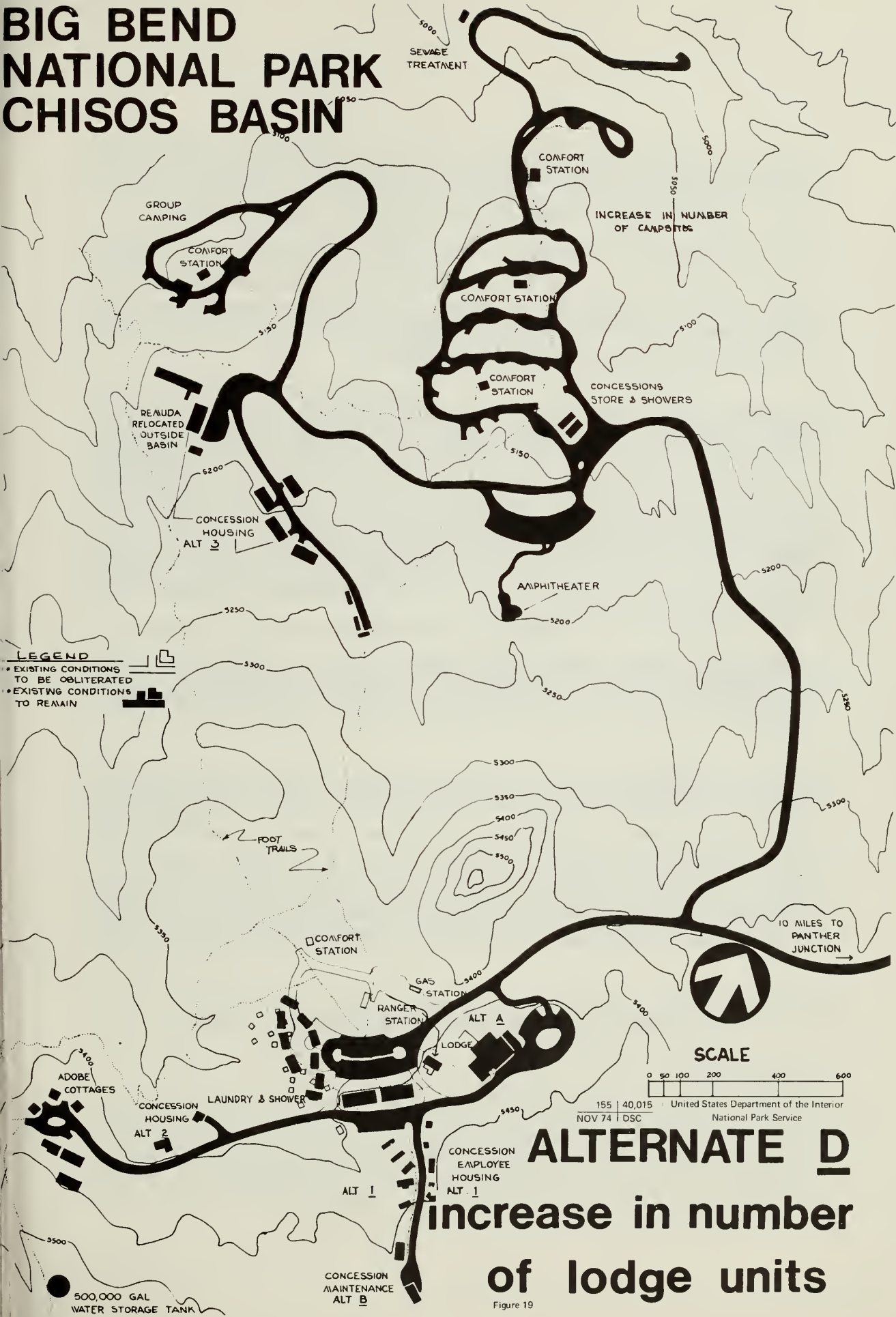
By expanding the overnight capacity of Chisos Basin, this alternative would allow more people to enjoy spending the night in the basin.

Water consumption for visitor accommodations, excluding the campground, would be increased to approximately 10,500 gallons per day. Total consumption under this alternative would depend on the number of new motel units built. For example, 30 units (4 pillows/unit) would increase the total possible demand to 10,360 gallons per day — an increase of 36 percent over what is currently used for overnight accommodations; 40 units would increase the total to 11,960 gallons per day — an increase of 58 percent. Concurrently, the amount of sewage would increase to roughly 90 percent of the volume of water consumed and used, or 9,400 gallons. The sewage-treatment plant that is presently under construction would be capable of handling the increased flow, so the impacts of sewage treatment would be similar to those discussed under alternative A.

There would be a somewhat greater impact on vegetation and wildlife. Depending upon design and construction techniques, there is the possibility that the new motel units would occupy a larger area than is now occupied by the Dallas huts, and a larger area would then be impacted. The greater expanses of paved and roofed areas might eventually alter drainage patterns even more than they have already been altered. The new and larger development might also be considered a greater visual intrusion by some people.

Also, more visitors would be using the new accommodations, and the impacts of the increase in human activity would extend beyond the motel site to affect natural features along foot trails and in other areas that are popular with visitors. Unless great care were taken in the design, construction, and use of these units, these greater levels of impact would probably cause an even greater shift toward the desert environment than is presently occurring in the basin.

BIG BEND NATIONAL PARK CHISOS BASIN



Since the restaurant was built for a larger capacity than is now using it, this alternative would be economically more favorable for the concessioner. The greater number of visitors would increase the concessioner's opportunity to sell goods and services.

Increasing the number of campsites in the lower basin campground would allow more visitors to stay in the basin, but this increased use would place a greater strain on the natural resources. Campground expansion would eliminate more of the native vegetation and, as with the construction of additional motel units, cause a greater shift toward the desert environment than is now occurring.

The present campground area is now heavily impacted due to the type of use it receives. Inasmuch as there is only limited room for expansion through the addition of more campground loops, new sites would have to be located between existing sites where feasible, and probably on terrain not exactly suited for this type development. This increased density could be displeasing to campers who prefer at least a 50-100 foot separation space from other campers. Native vegetative screening would be reduced also. An increase of paved and compacted area would alter the drainage patterns and cause more water to runoff rather than be absorbed, although more water would be available for absorption.

Construction of parking spurs for camper vehicles and of other appurtenant facilities would scar the landscape, creating raw cut and fill slopes that would be subject to erosion.

As with the addition of more motel units, the increase in campsites would boost the amount of water that is withdrawn from the Oak Springs supply. It is estimated that a camper family (average 3.5 campers/family) uses about 10 gallons of water per camper per day. Increasing the number of campsites from 71 to 91 would require that an additional 700 gallons of water be diverted from Oak Springs. Present campground water consumption is estimated at approximately 2,500 gallons per day. The addition of the 20 sites would increase water consumption 28 percent over what is currently used.

There would be a significant increase in air and noise pollution in the basin.

Mitigating Measures

Mitigating measures for alternative D would be the same as those discussed for alternative C with one addition. The number of NPS and concessioner employees living in the basin would be reduced in order to make more water available for visitors. This would help to mitigate the increased demands that would be placed on the Chisos Basin water system by an increase in overnight accommodations.

Unavoidable Adverse Effects

Significant unavoidable adverse effects of this alternative would be the same as those discussed under alternative C with two additions. Because the number of overnight accommodations would be increased under this alternative, construction sites would be expanded, and destruction of vegetation and wildlife habitat would occur on lands previously peripheral to developed sites.

Also, although attempts would be made to retain or reestablish the natural drainage patterns, the larger complex might make this impossible.

Short-Term/Long-Term Relationships

The expansion of the campground to allow more visitors to utilize the facilities in Chisos Basin would increase degradation of the environment in the campground and adjacent areas.

Development of the new motel units would enhance visual amenities and improve service to visitors, but at the same time, it would contribute to changing drainage patterns and vegetation in the basin.

Irreversible and Irretrievable Commitments of Resources

The materials, labor, and time consumed in planning and implementing the project would be irretrievably committed. No irreversible effects on the environment would occur because at any time the landscape could be restored to its natural condition.

ALTERNATIVE E: CUT BACK THE NUMBER OF CAMPGROUND UNITS AND RESIDENCES

This alternative suggests cutting back the number of camping spaces and employee residences in order to reduce the impact of development on the natural environment of Chisos Basin. This reduction would be combined with the removal and replacement actions outlined in alternative C.

Under this alternative the number of family campsites in the campground would be reduced from 71 to 30, leaving camping facilities for only about 130 people.

Housing for 2 NPS employees and 25 concessioner employees would remain in the basin. Two of the houses now used by NPS employees would be used by concessioner employees, while the five Dallas hut residences for concessioner employees would be removed and not replaced elsewhere in the basin. The other concessioner employee housing units would be replaced by a two-unit housing complex at one of the three

BIG BEND NATIONAL PARK CHISOS BASIN

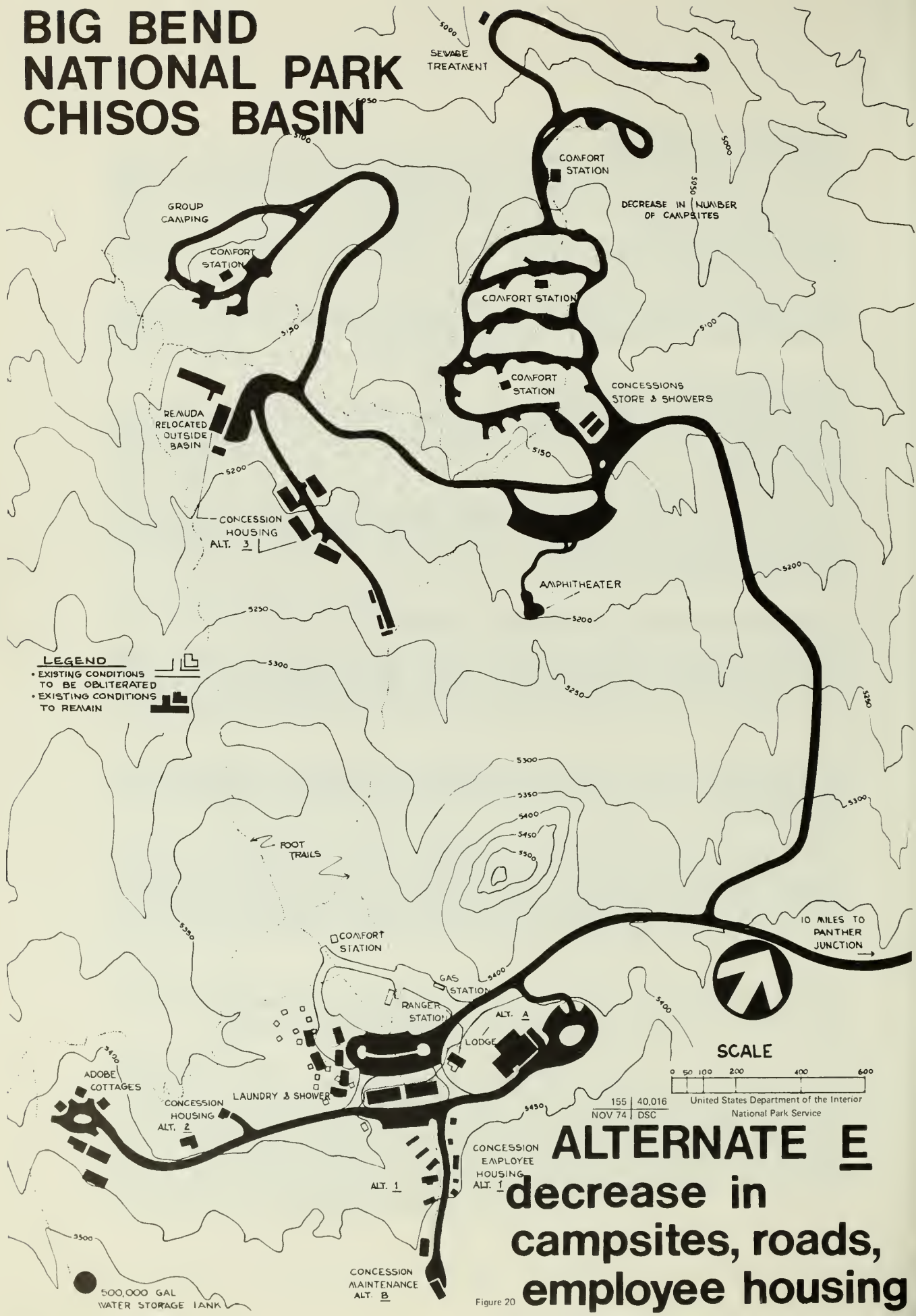


Figure 20

alternative housing sites. Modern housing would be provided for relocated employees in the Panther Junction residential area. A shuttle-bus system could be implemented to transport both NPS and concessioner employees to the basin to meet established work schedules. Emergencies requiring employees to work longer hours or at night could be handled by making a standby vehicle available to employees.

Impacts

This alternative would have the same impacts on the natural and social environments as outlined under alternative C, except that fewer people would be able to enjoy camping in the basin and there would be less impact on the basin environment in and around the campground area and the Dallas huts area due to the reduced number of units proposed under this alternative.

This alternative would result in some short-term visitor confusion and inconvenience as overnight facilities were reduced and possibly relocated outside the basin. For those people able to find spaces in the campground, camping would be a more enjoyable experience because of improved natural conditions and lower density of people per acre.

Employees moved out of the basin would likewise experience some short-term disruptions as they adapted their work schedules to use of a shuttle-bus system and their lifestyles to the environment in the Panther Junction developed area.

If the demand for overnight accommodations remained constant or increased, private enterprise would be encouraged to develop and construct modern high-standard campgrounds and lodge facilities at locations outside the basin.

Water consumption would be reduced by approximately 1,765 gallons per day, based on the reduced number of facilities. This would provide additional water reserves to meet future increases in day-use demands.

Mitigating Measures

Mitigating measures for this alternative would be the same as those discussed under alternative C, with one addition. Visitors unable to find space in the campground might be able to find comparable or higher standard facilities outside the basin.

Unavoidable Adverse Effects

Fewer people would be able to camp overnight in the basin. This alternative would have the same unavoidable impacts caused by construction activities as discussed under alternative C.

Short-Term/Long-Term Relationships

The natural environment in the basin would be improved by relocating some employee and visitor facilities and activities to another area.

Irreversible and Irretrievable Commitments of Resources

These commitments would be similar to those discussed under alternatives B and C.

CONSULTATION AND COORDINATION WITH OTHERS

The following persons and agencies were consulted during the preparation of this environmental assessment:

Ross Wilhite, Planning Director
City of Arlington, Texas

Mark W. Massenich, Urban Planner
Division of Management Services, City of Dallas, Texas

Truett Latimer, Executive Director,
and Dave Dibble
Texas State Historical Survey Committee, Austin, Texas

Paula Black, Geologist
Core Laboratories, Inc., Dallas, Texas

Constance Glaab, Librarian
Texana Collection, Southern Methodist University, Dallas, Texas

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APPENDIXES

- A: CORRESPONDENCE PERTAINING TO ARCHEOLOGICAL AND HISTORIC SITES
- B: ANIMAL AND PLANT CATEGORIES
- C: WATER DEMAND DATA
- D: CORRESPONDENCE PERTAINING TO SEWAGE-TREATMENT FACILITY
- E: TECHNICAL REPORT FOR CHISOS BASIN WASTEWATER TREATMENT PLANT
- F: INFORMATION SHEET, CHISOS MOUNTAIN LODGE

**A: CORRESPONDENCE PERTAINING TO ARCHEOLOGICAL AND
HISTORIC SITES**

EXHIBIT A



United States Department of the Interior
NATIONAL PARK SERVICE

Big Bend National Park, Texas 79834

IN REPLY REFER TO:

H2215

March 31, 1973

Mr. W. Glenn Ouzts
Myrick, Newman, Dahlberg, Inc.
2909 Lenmon Avenue
Dallas, Texas 75204

Dear Mr. Ouzts:

We are sorry to inform you that Superintendent Carithers is out of the park on business, so I am taking the privilege of answering your letter concerning archaeological and historical surveys in the developed portion of the Basin and at the proposed Ceniza Flat campground area.

Our reference for all archaeological sites located in Big Bend National Park is: "Archaeological Survey of the Big Bend National Park", 1966-67, T.N. Campbell. This report does not indicate any significant sites either in the developed portion of the Basin or the Ceniza Flat area. However, when development of the Ceniza Flat campground is done; a close examination for unknown sites should be undertaken. No historical sites are located in the Basin or Ceniza Flat.

We hope the above information will be of use to you and should you need further information please do not hesitate to write.

Sincerely yours,

Robert C. Morris
Acting Superintendent

EXHIBIT B



Texas State Historical Survey Committee

Box 12276, Capitol Station, Austin, Texas 78711

Truett Latimer

Executive Director

October 10, 1973

Ms. Donna Sue Comfort
Ecology Audits, Inc.
9995 Monroe Drive
Dallas, Texas 75220

RE: Chisos Basin and Ceniza Flats --- National Register of Historic Places

Dear Ms. Comfort:

Pursuant to your request by phone of this date, we have reviewed our files and find that at present there are no sites on the National Register of Historic Places within this area nor any in the process of submission or nomination to the National Register.

If we can be of further assistance in this or other matters, please advise.

Sincerely,

Truett Latimer
Executive Director

By

A handwritten signature in dark ink, appearing to read "Alton K. Briggs", written over a horizontal line.

Alton K. Briggs
Survey Archeologist

AKB:bjw

B: ANIMAL AND PLANT CATEGORIES

TABLE I : MAMMAL CATEGORIES OF THE CHISOS BASIN,
BIG BEND, TEXAS

SPECIES	Plant Association Range					
	I	II	III	IV	V	VI
Bat, Mexican Free-tailed (<u>Tadarida brasiliensis</u>)						
Bat, Western Mastiff (<u>Eumops perotis</u>)						
Bobcat (<u>Lynx rufus bacleyi</u>)						
Cottontail, Mountain (<u>Sylvilagus robustus</u>)						
Coyote (<u>Canis latrans</u>)						
Deer, Sonora White-tailed (<u>Odocoileus virginianus</u> <u>couesi</u>)						
Fox, Gray (<u>Urocyon cinereoargenteus</u>)						

KEY:

- I. Arroyo-Mesquite-Acacia Association.
- II. Lechuguilla-Creotebush-Cactus Association
- III. Sotol-Grass Association
- IV. Deciduous-Woodland Association
- V. Pinyon-Juniper-Oak Association
- VI. Cypress-Pine-Oak Association

TABLE I: (cont.)

SPECIES	Plant Association Range					
	I	II	III	IV	V	VI
Javelina (<u>Pecari angulatus</u>)						
Lion, Mountain (<u>Felis concolor</u>)						
Mouse, Brush (<u>Peromyscus boylii</u>)						
Mouse, Fulvous Harvest (<u>Reinthrondonotup flavesceus</u>)						
Mouse, Nelson Pocket (<u>Perognathus nelsoni</u>)						
Rat, White-throated Wood (<u>Neotoma albigula</u>)						
Rat, Yellow-nosed Cotton (<u>Signorodon ochroghauthus</u>)						

TABLE I. (cont.)

SPECIES	Plant Association Range					
	I	II	III	IV	V	VI
Ringtail (<u>Bassariscus astutus</u>)						
Skunk, Hog-nosed (<u>Conepatus leuconotus</u>)						
Skunk, Striped (<u>Mephitis mephitis</u>)						
Skunk, Western Spotted (<u>Spilogale putorius</u>)						
Squirrel, Spotted Ground (<u>Spermophilus spilosoma</u>)						

TABLE II: (cont.)

SPECIES	Plant Association Range					
	I	II	III	IV	V	VI
Snake, Black-tailed Rattle (<u>Crotalus m. mollossus</u>)						
Snake, Central Texas Whip (<u>Masticophis taeniatus</u> <u>ornatus</u>)						
Snake, Mexican Black-headed (<u>Tantilla otriceps</u>)						
Snake, Mountain Patch-nosed (<u>Salvadora g. grahamiae</u>)						
Snake, Western Diamondback Rattle (<u>Crotalus atrox</u>)						
Whiptail, Big Bend (<u>Cnemidophorus scalaris</u> <u>septemvittatus</u>)						

TABLE II: (cont.)

SPECIES	Plant Association Range					
	I	II	III	IV	V	VI
AMPHIBIANS						
Frog, Canyon Tree (<u>Hyla arenicolor</u>)						
Frog, Texas Cliff (<u>Syrrophus marnocki</u>)						

TABLE III
DISTRIBUTION OF BREEDING BIRDS IN THE CHISOS BASIN
BY ECOLOGICAL ASSOCIATIONS
AND THEIR RESPONSE TO HUMAN DEVELOPMENT

	IV	V
Turkey Vulture	T	T
Zone-tailed Hawk	-	
Golden Eagle		T
Sparrow Hawk		T
White-winged Dove	O	
Mourning Dove	O	
Roadrunner	-	
Screech Owl	T	T
Great Horned Owl	T	
Elf Owl	T	
Poor-will		-
White-throated Swift		T
Black-chinned Hummingbird	O	
Broad-tailed Hummingbird	-	-
(cont.)		

KEY: - Response not known

O No effect

F Favored by development

T Timid: negative response

IV Deciduous-Woodland Association

V Pinyon-Juniper-Oak Association

TABLE III: (cont.)

	IV	V
Acorn Woodpecker	-	-
Ladder-backed Woodpecker	O	O
Ash-throated Flycatcher	T	T
Say's Phoebe	F	
Violet-green Swallow		O
Mexican Jay	T	T
Bushtit	-	-
Bewick's Wren	F	F
Cactus Wren	F	F
Canyon Wren	O	O
Rock Wren	O	O
Mockingbird	F	F
Crissal Thrasher	-	-
Blue-gray Gnatcatcher	T	T
Hutton's Vireo		-
Gray Vireo	O	
House Sparrow		-
Brown-headed Cowbird	F	
Scott's Oriole	T	T
Hepatic Tanager		-
Summer Tanager	-	
Pyrrhuloxia	F	
Black-headed Grosbeak	T	T
Blue Grosbeak	-	
Varied Bunting	-	
House Finch	F	
(cont.)		

TABLE III: (cont.)

	IV	V
Lesser Goldfinch	-	
Rufous-sided Towhee	-	-
Brown Towhee	T	T
Rufous-crowned Sparrow	-	-
Black-chinned Sparrow	-	-

TABLE IV
VEGETATION CATEGORIES OF THE CHISOS BASIN,
BIG BEND, TEXAS

SPECIES	V	IV	III
TREES:			
<i>Fraxinus cuspidata</i> Torr. (Fragrant ash)	X		
<i>Juniperus deppeana</i> Steud. (Alligator juniper)	XX		
<i>Juniperus pinchoti</i> Sudw. (Redberry juniper)	XX		
<i>Juniperus flaccida</i> Schlecht. (Drooping juniper)	XX		
<i>Arbutus texana</i> Buckl. (Texas madrone)	XX		
<i>Pinus cembroides</i> Zucc. (Mexican pinyon)	XXX		
<i>Quercus gravesii</i> Sudw. (Graves oak)	XXX		X
<i>Quercus emoryi</i> Torr. (Emory oak)	XXX	X	XX
<i>Quercus grisea</i> Liebm. (Gray oak)	XX	X	X
<i>Prosopis glandulosa</i> Torr. (Honey mesquite)	XX		X
<i>Quercus intricata</i> Trel. (Dwarf oak)		XX	
<i>Quercus pungens</i> Liebm. (Sandpaper oak)		XX	
<i>Celtis reticulata</i> Torr. (Netleaf hackberry)			X
<i>Acacia roemeriana</i> Scheele (Roemer acacia)			X
<i>Ungnadia speciosa</i> Endl. (Mexican buckeye)			X
<i>Diospyros texana</i> Scheele (Texas persimmon)			X
SHRUBS:			
<i>Forestiera neomexicana</i> (New Mexico forestiera)	X		
<i>Ceanothus greggi</i> Gray (Desert ceanothus)	X		
<i>Prunus serotina</i> Ehrhart (Southwestern chokecherry) subsp. <i>virens</i> (Woot. & Standl.) McVaughn	X		
<i>Aloysia wrightii</i> (Gray Heller (Wright aloysia)	XX		
(cont.)			

KEY: III Sotol-Grass Association
 IV Deciduous-Woodland Association
 V Pinyon-Juniper-Oak Association
 X Sighted or collected
 XX Less than 40 sighted or collected
 XXX Greater than 40 sighted or collected

TABLE IV: (cont.)

SPECIES		V	IV	III
SHRUBS:	<i>Isocoma coronopifolia</i> (Gray) Greene	XX		
	<i>Bouvardia ternifolia</i> (Cav.) Schlecht. (Scarlet bouvardia)	XX		
	<i>Rhamnus betulaeifolia</i> Greene (Birchleaf buckthorn)	XX		
	<i>Salvia regla</i> Cav. (Mountain sage)	XX		
	<i>Garrya lindheimeri</i> Torr. (Lindheimeri silktassel)	XX	X	
	<i>Rhus aromatica</i> Ait. (Skunkbush) var. flabelliformis Shinnery	XX	XX	
	<i>Berberis haematocarpa</i> Woot. (Red barberry)	X	X	
	<i>Larrea tridentata</i> Cav. (Creosotebush)	X	X	XX
	<i>Viguiera stenoloba</i> Blake (Skeleton goldeneye)	XX	XX	XX
	<i>Cercocarpus montanus</i> Raf. (Silverleaf mountainmahogany) var. argenteus (Rydb.) F.L. Martin	XX	XXX	XX
	<i>Rhus virens</i> Lindh. ex Gray (Evergreen sumac)	XX	XX	XXX
	<i>Zexmenia brevifolia</i> Gray (Shorthorn zexmenia)	XX		
	<i>Aloysia lycioides</i> Cham. (Whitebrush)	XX		X
	<i>Mimosa biuncifera</i> Benth. (Catclaw mimosa)	XX		XX
	<i>Acacia constricta</i> Benth. ex Gray (Mescat acacia)	XXX		XX
	<i>Condalia lycipides</i> (Gray) Weberb. (Southwest condalia)	X		X
	<i>Condalia spathulata</i> Gray (Knifefleaf condalia)	X		X
	<i>Ptelea trifoliata</i> L. (Hoptree)	X		X
	<i>Parthenium incanum</i> H.B.K. (Mariola)	X		X
	<i>Fraxinus greggi</i> Gray (Gregg ash)		XXX	XXX
	<i>Glossopetalon spinescens</i> Gray (Spiny grease bush)		XX	XX
	<i>Ephedra nevadensis</i> Wats. (Boundary ephedra) var. aspera (Engelm.) L. Benson			XX
	<i>Krameria glandulosa</i> Rose & Painter (Range ratany)			XX
	<i>Dalea frutescens</i> Gray (Black dalea)			XX
	<i>Leucophyllum minus</i> Gray (Big Bend silverleaf)			X
	(cont.)			

TABLE IV: (cont.)

SPECIES		V	IV	III
SHRUBS:	<i>Eysenhardtia texana</i> Scheele (Texas kidneywood)			X
	<i>Vauquelinia angustifolia</i> Rydb. (Slimleaf vauquelinia)			X
	<i>Baccharis glutinosa</i> (Ruiz & Pavon) Pers. (Seepwillow)			X
	<i>Rhus microphylla</i> Engelm. ex Gray (Littleleaf sumac)			X
	<i>Anisacanthus insignis</i> Gray (Dwarf anisacanthus)			X
	<i>Atriplex canescens</i> (Pursh) Nutt. (Fourwing saltbush)			X
	<i>Sophora secundiflora</i> (Ort.) Lag. ex DC. (Mescalbean)			X
	<i>Dicraurus leptocladus</i> Hook. (Tainbush)			X
SUCCULENT- SEMI-				
SUCCULENTS:	<i>Agave chisoensis</i> C.H. Mueller (Chisos agave)	X		
	<i>Nolina erumpens</i> (Torr.) Wats. (Foothill nolina)	XX	XX	
	<i>Agave scabra</i> Salm0Dyck	XX	XX	
	<i>Opuntia engelmannii</i> Parry (Engelmann pricklypear)	XX	XX	XX
	<i>Agave lecheguilla</i> Torr. (Lechuguilla)			XXX
	<i>Opuntia imbricata</i> Haw. (Cholla)			X
	<i>Opuntia kleiniae</i> DC. (Candle cholla)			X
	<i>Opuntia leptocaulis</i> DC. (Pencil cholla)			X
GRASSES:	<i>Cenchrus incertus</i> Curtis (Sandbur)	X		
	<i>Eragrostis barrelieri</i> Daveau. (Mediterranean lovegrass)	X		
	<i>Andropogon gerardi</i> Vitm. (Big bluestem)	X		
	<i>Stipa eminens</i> Cav. (Southwestern needlegrass)	XX		
	<i>Aristida orcuttiana</i> Vasey (Single threeawn)	XX		
	<i>Aristida divaricata</i> Humb. & Bonpl. ex Willd. (Poverty threeawn)	XX		
	<i>Stipa tenuissima</i> Trin. (Finestem needlegrass)	XXX		
	<i>Piptochaetium fimbriatum</i> (H.B.K.) Hitchc. (Pinyon-ricegrass)	XXX		
	<i>Eragrostis intermedia</i> Hitchc. (Plains lovegrass)	XX	X	
	(cont.)			

TABLE IV: (cont.)

	SPECIES	V	IV	III
GRASSES:	<i>Bouteloua gracilis</i> (Willd. & H.B.K.)			
	Lag. ex Griff. (Blue grama)	XXX	XX	X
	<i>Muhlenbergia emersleyi</i> Vasey (Bull-grass)	XXX	XX	XX
	<i>Bouteloua curtipendula</i> (Michx.) Torr. (Sideoats grama)	XXX	XXX	XXX
	<i>Lothriochlea barbinodis</i> (Lag.) Herter (Cane bluestem)	XX	XX	XX
	<i>Aristida glauca</i> (Nees) Walp. (Blue threeawn)	XX	XX	XX
	<i>Lycurus phleoides</i> H.B.K. (Wolftail)	X	X	XX
	<i>Setaria macrostachya</i> H.B.K. (Plains bristlegrass)	XX		X
	<i>Hilaria mutica</i> (Buckl.) Benth. (Tobosagrass)	XX		X
	<i>Muhlenbergia rigida</i> (H.B.K.) Kunth. (Purple muhly)	XX		XX
	<i>Sorghum halpense</i> (L.) Pers. (Johnsongrass)	X		X
	<i>Bouteloua hirsuta</i> Lag. (Hairy grama)	X		XXX
	<i>Schizachyrium scoparium</i> (Michx.) Nash (Little bluestem)			XXX
	<i>Heteropogon contortus</i> (L.) Beauv. (Tanglehead)			XX
	<i>Bouteloua breviseta</i> Vasey (Chino grama)			XX
	<i>Bouteloua eriopoda</i> (Torr.) (Black grama)			XX
	<i>Panicum hallii</i> Vasey (Halls panicum)			X
	<i>Panicum obtusum</i> H.B.K. (Vinemesquite)			X
	<i>Bromus unioloides</i> (Willd.) H.B.K. (Rescuegrass)			X
	<i>Cynodon dactylon</i> (L.) Pers. (Bermudagrass)			X
	<i>Muhlenbergia porteri</i> Scribn. (Bush muhly)			X
	<i>Erioneuron pulchellum</i> (H.B.K.) Tateoka (Fluffgrass)			X
	(cont.)			

TABLE IV: (cont.)

SPECIES	V	IV	III
GRASSES:			
<i>Erioneuron grandiflorum</i> (Vasey)			
Tateoka			X
<i>Sporobolus cryptandrua</i> (Torr.)			
Gray (Sand-dropseed)			X
<i>Leptochloa dubia</i> (H.B.K.) Nees			
(Green spangletope)			X
<i>Panicum bulbosum</i> H.B.K. (Bulb panicum)			X
<i>Aristida ternipes</i> Cav. (Spidergrass)			X
<i>Digitaria californica</i> (Benth.) Henr.			
(Arizona cottontop)			X
<i>Chloris virgata</i> Swartz (Showy chloris)			X
<i>Echinochloa crusgalli</i> (L.) Beauv.			
(Barnyardgrass)			X
HERBS:			
<i>Conyza sophiaefolia</i> H.B.K. (Leafy conyza)	X		
<i>Heliopsis parvifolia</i> Gray (Mountain heliopsis)	X		
<i>Euphorbia villifera</i> Scheele (Hairy euphorbia)	X		
<i>Pallaea intermedia</i> Mett. ex Huhn (Creeping cliffbrake) var.			
pubescens (Mett.) Brown	X		
<i>Ximenesia encelioides</i> Cav.			
(Golden crownweed)	X		
<i>Euphorbia strictospora</i> Engelm.			
(Slimseed euphorbia)	X		
<i>Cissus incisa</i> (Nutt.) Des Moulins)			
Ivy treebine)	X		
<i>Phanerophlebia umbonata</i> Underw.	X		
<i>Phorandendron bolleanum</i> (Seem.)			
Eichler (Rough mistletoe)	X		
<i>Eriogonum wrightii</i> Torr. (Wright wildbuckwheat)	XX		
<i>Cheilanthes eatoni</i> Baker (Eaton lipfern)	XX		
<i>Perezia nana</i> Gray (Desertholly perezia)	XX		
(cont.)			

TABLE IV: (cont.)

	SPECIES	V	IV	III
HERBS:	Aletes acaulis (Torr.) Coult. & Rose (Stemless aletes)	XX		
	Lonicera albiflora T. & G. (Bushy honeysuckle) var. dumosa Gray	XX		
	Senecio millelobatus Rydb. (Manybract groundsel)	XX		
	Artemesia ludoviciana Nutt. (Sagwort) var. albula (Wooten) Shinnars	XXX		
	Erigeron modestus Gray (Plains fleabane)	XXX		
	Galium wrightii Gray (Rothrock bedstraw) var. rothrockii (Gray) Ehrendorfer	XXX		
	Eriogonum hemipterum (T. & G.) Stokes (Wildbuckwheat)	X	XX	
	Hedyotis fasciculata (Bertol.) Small (Cluster bluet)		XX	
	Pellaea microphylla Mett. ex Kuhn. (Littleleaf cliffbrake)		XX	
	Ipomopsis aggregata (Pursh) V. Grant (Skyrocket ipomopsis) var. texana (Greene) Shinnars		X	
	Xanthocephalum lucidum Greene (Sticky snakeweed)		X	
	Xanthocephalum microcephalum (DC.) Shinnars (Threadleaf snakeweed)	XX	XX	XX
	Chrysactinia mexicana Gray (Damianita)	XX	XX	XX
	Melampodium leucanthus T. & G. (Plains blackfoot)	XX		XX
	Bommeria hispida (Mett.) Underw. (Hairy bommeria)	XX		X
	Eupatorium greggi Gray (Palmleaf eupatorium)	XX		X
	(cont.)			

TABLE IV: (cont.)

SPECIES	V	IV	III
HERBS:			
<i>Machaeranthera pinnatifida</i> (Hook.)			
Shinners	X		X
<i>Tribulus terrestris</i> L. (Puncturevine)	X		X
<i>Alternanthera peploides</i> (H. & B.)			
Urban (Mat chaff-flower)	X		X
<i>Solanum elaeagnifolium</i> Cav.			
(Silverleaf nightshade)	X		X
<i>Croton pottsii</i> (Klotzsch.) Muell.			
Arg. (Leatherweed croton)	X		XX
<i>Euphorbia cinerescens</i> Engelm.			
(Ashy euphorbia)			XX
<i>Notholaena sinuata</i> (Lagasca) Kaulf.			
(Cloakfern) var. <i>integerrima</i> Hook.			XX
<i>Polygala longa</i> Blake (Narrowleaf milkwort)			XX
<i>Polygala alba</i> Nutt. (White milkwort)			XX
<i>Hedyotis polypremoides</i> (Gray) Shinners			XX
<i>Menodora scabra</i> Gray (Smooth menodora)			
var. <i>laevis</i> (Woot. & Standl.) Steyermark			XX
<i>Brickellia veronicaefolia</i> (H.B.K.) Gray			
(Brickellbush) var. <i>petrophila</i> B.L.			
Robinson			XX
<i>Notholaena sinuata</i> (Lagasca) Kaulf.			
(Bulb cloakfern) var. <i>sinuata</i>			XX
<i>Polygala scoparioides</i> Chod. (Broom milkwort)			X
<i>Marrubium vulgare</i> L. (Common horehound)			X
<i>Croton fruticulosus</i> Engelm. (Bush croton)			X
<i>Boerhaavia coccinea</i> Mill. (Scarlet spiderling)			X
<i>Sphaeralcea angustifolia</i> (Cav.) D. Don.			
(Globemallow)			X
<i>Porophyllum scoparium</i> Gray (Poreleaf)			X
<i>Baileya multiradiata</i> Harvey & Gray			
(Desert bailey)			X
<i>Senecio longilobus</i> Benth. (Threadleaf			
groundsel)			X
(cont.)			

C: WATER DEMAND DATA

WATER DEMANDS

General:

Oak Springs is the primary and Cattail Creek serves as a supplemental source of water to satisfy the water demands at Chisos Basin.

Present Water Supply System:

Water from Oak Springs is collected and flows by gravity to two steel above ground reservoirs with a combined capacity of 525,000 gallons located by the springs. The water is pumped approximately 1,500 ft. in elevation to an additional above ground steel 500,000 gallon storage tank in Chisos Basin at a maximum pumping rate of 50 gpm. All water demands within the basin are gravity flowed from the 500,000 gallon reservoir to the user.

Supplemental emergency water from Cattail Creek is collected by an infiltration gallery located in the streambed approximately 200 feet downstream from Cattail Falls. The water is gravity flowed to the storage reservoirs located at Oak Springs.

Oak Springs System was completed in 1955. The Cattail Creek addition was completed in 1956.

Yearly Water Demand

The water demands for all needs at Chisos Basin has increased through the years at the following rates:

Year	Avg. Consumptive gpm/yr.	Total Yearly Demand (Gal.)	Avg. Water Demand Visitor/Yr. (Gal.)
1958	4.9	2,575,440	—
1961	6.1	3,206,160	—
1963	7.8	4,099,680	—
1965	8.5	4,467,600	—
1967	14.9	7,831,440	—
1969	15.4	8,116,924	100
1970	18.2	9,560,439	95
1971	23.4	12,323,647	99
1972	20.4	10,717,720	77
1973	21.4	11,264,635	85
1974	15.4*	4,041,800*	77*

* Computed from January to June inclusive.

Using 1973 calendar year as an example, the distribution of water was reported as follows:

Activities	Quantity (Gal.)	Determination
Total Water Demand	11,264,635	Meter
National Park Concession	6,239,764	Meter
Remuda Operation	392,010	Meter
National Park Service	1,701,500	Estimated
Unaccounted-for Water	2,931,361	Computed

A detailed breakdown of water users reported in 1973 follows:

Facility	Gal/Yr.	% of Total Demand	Remarks
National Park Concession			
Service Station	25,240	0.2	
Bath House	1,692,042	15.0	
Old Motel	995,000	8.8	
New Motel	541,490	4.8	
Cabin No. 100	114,530	1.0	
Cabins — Other Total	710,100	6.3	
Dormitory — Upper	264,200	2.3	
Dormitory — Lower	145,141	1.3	
Quarters — 1st	19,864	0.2	
Quarters — 2nd	117,133	1.0	Includes irrigation
Office & Rec. Hall	109,050	1.0	
Basin Store	121,764	1.1	
Lodge Unit	1,384,210	12.3	
Remuda Operation	392,010	3.5	Includes avg. 30 horses/year and caretaker residences
National Park Service (Estimated)			
Campground (Total)	1,117,500	10.0	25 Gal/visitor/day
Residences (Total)	584,000	5.2	Avg. 16 resident @ 100 gal/day
Unaccounted-for Water	2,931,361	26.0	

Conditions which affect the amount of unaccounted-for water are unknown but may be due to any one or combination of the following: pressures and variation of pressures throughout the system, the length, condition and age of the pipe system and service lines, ratio of larger users to total service and the lack of maintenance given to leakage and unauthorized taps of water, lack of meter maintenance or attention to overflow conditions at the upper reservoir at Chisos Basin.

Visitation:

Quantities of water used is basically related to the number of visitors and the mixture of type of visitor use experienced. Based on historical data (1970-1974), we find that the percentage of total visitors recorded at Chisos Basin to total park visitation has fluctuated as follows:

Year	% Chisos Visits to Park Visits	% Chisos Visitors to Chisos Use		
		Lodge	Campground	Day
1970	83.7	28.3	33.5	38.2
1971	54.1	33.8	40.6	25.6
1972	47.8	31.4	39.1	29.5
1973	38.7	32.0	33.8	34.2
1974*	51.8	33.8	49.2	17.0

* Computed for months of January to June inclusive.

Seasonal variations are such that during the traditional summer holidays (June to August) we find in the same historical data that the visitation varies from 31 percent to 42 percent of the total yearly park visitation. This figure is approximately 1/2 the figure recorded in many other parks. The highest single visitation month is April when the monthly visitation has fluctuated between 8.1 percent to 18 percent of the total yearly park visitation.

Average water use can be expected to fluctuate accordingly. For the 1973 year the following water requirements are estimated:

Water Demand	Quantities (Gal.)
Avg. Daily	30,862
Max. Daily	61,724

Records of maximum daily peak consumption, minimum and extreme minimum daily consumption figures are not available.

* Computed for months of January to June inclusive.

D: CORRESPONDENCE PERTAINING TO SEWAGE-TREATMENT FACILITY



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VI
1600 PATTERSON, SUITE 1100
DALLAS, TEXAS 75201

May 1, 1973

Mr. R. S. Budz
Team Manager
Southwest Team
National Park Service
Denver Service Center
7200 W. Alameda
Denver, Colorado 80226

Dear Mr. Budz:

This is in reference to your letter of March 28, 1973, requesting our review of the Technical Report for the proposed Chisos Basin Waste Water Treatment Plant, Big Bend National Park, Brewster County, Texas.

We have completed our review of that report. We have also coordinated our review with the Texas Water Quality Board and the Texas State Department of Health. It is our combined opinion that based on this preliminary data, your concept appears sound. We will await your plans and specifications for final concurrence.

Copies of the State letters will be forwarded at a later date. Your cooperation is appreciated.

Sincerely yours,

A handwritten signature in dark ink, reading "James T. Highland". The signature is fluid and cursive, with a large loop at the end.

James T. Highland, P.E.
Acting Chief
Technical Support Section
Federal Assistance Branch

cc: Texas Water Quality Board
Austin, Texas

Texas State Dept. of Health
Austin, Texas

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A.C. 512

314 WEST 11TH STREET 78701
P.O. BOX 13246 CAPITOL STATION 78711
AUSTIN, TEXAS

April 18, 1973

Re: Chisos Basin Wastewater
Treatment Plant
Big Bend National Park
U. S. Park Service

Environmental Protection Agency
Water Quality Office, Region VI
1600 Patterson Street, Suite 1100
Dallas, Texas 75201

Attn: Mr. William B. Hathaway

Gentlemen:

Reference is made to your letter of April 2, 1973, transmitting the Engineering Data and Technical Report for the proposed wastewater treatment facility in the Chisos Basin area of the Big Bend National Park.

Since this project does not involve P.L. 660 funds, the Texas State Department of Health will be the agency to provide comments on the adequacy of the proposed facilities. In our review of the information submitted, we noted that the lagoons are apparently to be operated in parallel. We would suggest that series operation might provide more adequate treatment.

An application for a waste control order was included in the report submitted by the Raymond L. Goodson, Jr., Inc. firm. Inasmuch as waste control orders are not being written for federal installations we will preserve the application in the file for this entity without further action.

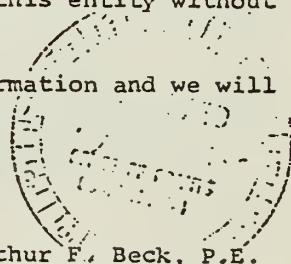
Thank you for the opportunity to review this information and we will be glad to have the material in our files.

Sincerely,


Robert G. Fleming, P.E., Director
Central Operations

JMJ:jh

ccs: Mr. Arthur F. Beck, P.E.
TWQB District 10
Mr. J. C. Newell, Field
Operations Division





Texas State Department of Health

JAMES E. PEAVY, M.D., M.P.H.
COMMISSIONER OF HEALTH

FRATIS L. DUFF, M.D., Dr. P.H.
DEPUTY COMMISSIONER

AUSTIN, TEXAS

April 18, 1973

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Mr. Arthur W. Busch, P.E.
Regional Administrator
Environmental Protection
Agency, Region VI
1600 Patterson, Suite 1100
Dallas, Texas 75201

RE: Chisos Basin
Wastewater Treatment Plant
Big Bend National Park
Brewster County, Texas

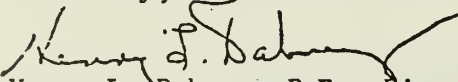
ATTENTION: Mr. William B. Hathaway
Technical Support Section
Federal Assistance Branch

Dear Mr. Busch:

A letter dated April 2, 1973, and signed by Mr. William B. Hathaway, of the Technical Support Section, forwarded engineering data and a technical report for the proposed wastewater treatment facilities to serve areas of the Big Bend National Park in the Chisos Basin area. The proposal called for the installation of two extended aeration sewage treatment plants, one having a daily treatment capacity of 20,000 gallons, and the other 30,000 gallons. Effluent from the units will be discharged into the two oxidation ponds, constructed to operate in series, from which the effluent will be chlorinated and discharged into Oak Canyon.

Our review of this proposed facility, planned by the U. S. Park Service, indicates that the plans have been prepared in general accordance with the requirements of our Design Criteria. We have no objection to the treatment and wastewater management procedures outlined in the report, and feel that any final plans and specifications prepared for the project will be subject to our approval, if prepared as outlined.

Sincerely,


Henry L. Dabney, P.E., Director
Division of Wastewater Technology
and Surveillance

THROUGH:


G. R. Herzik, Jr., P.H.
Deputy Commissioner for
Environmental Health

DNC/dec

cc: Public Health Region 3
Texas Water Quality Board

Southwestern

LABORATORIES TESTING ENGINEERS

SOILS ENGINEERING DIVISION

612 GREAT SOUTHWEST PARKWAY • BOX 1526 • ARLINGTON, TEXAS 76010

February 19, 1973



817/261-0771

Re: Soil Sample
Chisos Basin
SWL Report No. UB3-29

Raymond L. Goodson, Jr., Inc.
2909 Lemmon Ave.
Dallas, Texas

Attention: Mr. Fritz Beck

Gentlemen:

We have completed the laboratory testing which you requested on the above referenced sample. These tests included an Atterberg Limits series, volumetric shrinkage, Standard Proctor Moisture-Density Relationship and permeability tests. The results are summarized below.

Atterberg Limits Series

<u>Liquid Limit</u>	<u>Plastic Limit</u>	<u>Plasticity Index</u>
32	20	12

Volumetric Shrinkage

24.5% from a moisture content of 31.0%

Standard Proctor Moisture-Density Relationship

Maximum Density - 107.6 pcf
Optimum Moisture - 18.1%

Permeability Tests

Coefficient of permeability - 6×10^{-7} cm/sec
Sample molded @ 93 pcf

Southwestern
LABORATORIES

We trust that the above information is of benefit to you. Please contact us if we can be of any further assistance.

Sincerely,

SOUTHWESTERN LABORATORIES

Ralph B. Barnes

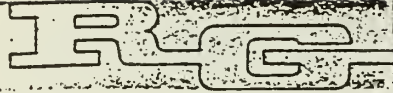
Ralph B. Barnes, MSCE
Soils Engineering Division

RBB:kc

Exhibit 2

PRELIMINARY CONSTRUCTION COST ESTIMATE

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	A M O U N T	G R A N D T O T A L
1,000	C.Y.	Rock Excavation	\$ 10.00	\$ 10,000.00	
280	L.F.	6 Inch Vitrified Clay Pipe	8.00	2,240.00	
100	L.F.	Plant Piping	5.00	500.00	
700	L.F.	1 Inch Copper Waterline to Plant	4.00	2,800.00	
1	Each	Post Hydrant	80.00	80.00	
1	L.S.	Extended Aeration Plant		100,000.00	
1	L.S.	Sand Drying Bed		2,720.00	
1	L.S.	Splitter Box		300.00	
1	L.S.	Stabilization Pond Discharge and Chlorinator		2,000.00	
700	L.F.	Underground Electrical	10.00	7,000.00	
1	L.S.	Testing Equipment and Flow Recorder		800.00	
140	S.Y.	Asphalt Paving	6.00	840.00	
340	L.F.	6 Foot Chain Link Fence	8.00	<u>2,720.00</u>	
					\$132,000.00
Ten Percent (10%) for Contengencies					<u>13,200.00</u>
					\$145,200.00



RAYMOND L. GOODSON, JR., INC. CONSULTING ENGINEER

2909 LEMMON AVE. • DALLAS, TEXAS 75204 A/C 214/528-2200

March 16, 1973

Myrick-Newman-Dahlberg, Inc.
2909 Lemmon Avenue
Dallas, Texas 75204

RE: Chisos Basin Sewage Treatment

Gentlemen:

Pursuant to our contract with you we are submitting, herewith, the results of our studies on subject project. These results are briefly described below and on the accompanying attachments.

EXISTING SEWAGE TREATMENT

At the present time raw sewage is deposited into two stabilization ponds where the action of bacteria and algae working together bring about a stabilized organic matter. Water from these two ponds evaporates, soaks into the ground, or at some times of the year overflows the pond banks. This type of sewage treatment is not now permitted by the Texas State Health Department unless proceeded by primary treatment.

WATER CONSERVATION METHODS STUDIED

In an effort to conserve water and properly dispose of waste water effluent we have investigated eleven different methods. These are presented below along with our brief comments.

1. Secondary Treatment Followed by Injection into Ground. A permability test run on soil in the vicinity of the stabilization ponds shows an imperbable soil with a moisture penetration of about 0.6 foot per year. A copy of this test report is attached as Exhibit 1. The permability is not enough to adequately dissipate the plant effluent so this method will not work. Another method of injection is to drill a well which is founded in a permable layer through which the effluent is dissipated. Much geologic investigation is required to insure that effluent will not eventually get back into the drinking water supply. Because of the uncertainties in this method, we think it would be difficult to get a permit to do this.

2. Secondary Treatment Followed by Irrigation. Irrigation will create a green area which is not natural to the area. In addition, effluent will be lost through transpiration or evaporation. In an arid region I consider this bad because it prevents further use of the water except when it is returned to the earth somewhere else as rainfall.
3. Secondary Treatment Followed by Drainage Field. The drainage field referred to here is a series of pipes laid at shallow depth where the effluent can seep into the soil as is done with septic tanks. The impermeable nature of the soil excludes this type of system as explained in number one above.
4. Secondary Treatment Followed by Stabilization Ponds Where Effluent Evaporates. This system as in number two above loses the effluent which prevents further use except when it is returned as rainfall.
5. Secondary Treatment Followed by Spraying for Evaporation. This method has the same disadvantages as the preceding one.
6. Secondary Treatment and Pump-out Window to Below Oak Springs. The cost of pipe and pumps will be high in addition to scarring the landscape. This method does keep the water in the park where it will flow down Oak Canyon as it did naturally before the development of Oak Springs water supply.
7. Secondary Treatment and Pump-out of Basin into Green Gulch. Same as number six, except water is put into different drainage area.
8. Tertiary Treatment Followed by Mixing with Potable Water for Reuse. The re-use of sewage effluent is not well accepted by people in this country and the costs of this will be high. Besides, very experienced people will be required to operate the plant and laboratory facilities.
9. Secondary Treatment and use Effluent for Toilet Flushing. This will reduce water consumption about 30 percent, however it will require pumping and storage facilities along with a separate plumbing system to each toilet. This will increase the number of people which can be accommodated in the basin. Without an increase of people, water which is saved will flow down Oak Canyon from the springs without being used by man.
10. Use Gas, Electrical or Chemical Toilets. This is similar to number nine above in that it will increase the number of people which can be accommodated and let unused water flow in Oak Canyon. In addition, the chemical toilets will add a highly concentrated influent to the sewage treatment facilities which will raise the effluent BOD above the normal levels.
11. Secondary Treatment Followed by Stabilization Ponds and Discharging into Canyon Leading to Window. This is the preferred method of treatment because it provides for the most amount of treatment through use of the existing stabilization ponds and then lets out each day a certain amount of water to flow in the canyon leading to the window. Some of the water will soak into the ground, some will

evaporate, and at times some may go out through the window. This will be an economical way to dispose of the water while keeping it in the park system as long as possible. That water which flows out the window will flow past Oak Springs and can be used to recreate the natural vegetation which once grew before diverting the water for basin use.

METHOD SELECTED FOR WASTE WATER DISPOSAL

The method preferred for disposal of waste water is to process through secondary stage and discharge into stabilization ponds where further treatment by natural methods is obtained. Then discharge daily an amount equal to the pond in flow less evaporation. This is method number 11 above.

ESTIMATED MAXIMUM FLOW

A report which you furnished us entitled "Chisos Basin-Development Concept Plan" has been of much help to us in checking the quantity of waste water for the maximum month and establishing the relationship between each of the other months. Using more recent data furnished by NPS we have attempted to check the number of people in the basin and find that the 1968 figures are fairly representative of today's figures. In view of this, and the fact that you are not planning to increase the daily population of the basin in the future we have calculated the average daily waste water flow during the peak month as follows using a combination of the report figures and your figures for employees and dependents.

UNIT WASTE WATER FLOW AND LOAD

Item	Unit	Gallon/unit/day	BOD ₅ /unit/day
Rental Unit with Bath	person	55	0.12
Resident (employees and families)	person	80	0.17
Non-resident employees	person	9	0.03
Overnight camper	person	50	0.12
Day visitor (comfort only)	person	3	0.01
Restaurant meals (includes visitor and non-resident employees)	meal	6	0.02

WASTE WATER FLOW AND BOD LOAD

	Flow gal/day	BOD lbs/day
Day visitor	1040x3 = 3,120	1040x.01 = 10.40
Camper	340x50 = 17,000	340x.12 = 40.80
Lodger	165x55 = 9,075	165x.12 = 19.80

	<u>Flow gal/day</u>		<u>BOD₅ lbs/day</u>	
Resident Concession Employee+Dependent	20x80	= 1,600	20x.17	= 3.40
Resident Remuda Employee+Dependent	16x80	= 1,280	16x.17	= 2.72
Resident NPS Employee+Dependent	39x80	= 3,120	39x.17	= 6.63
Meals, Day Visitor	200x6	= 1,200	200x.02	= 4.00
Meals, Camper	68x3x6	= 1,224	204x.02	= 4.08
Meals, Lodger	165x3x6	= 2,970	495x.02	= 9.90
Meals, non Resident Employee	70x3x6	= 1,260	210x.02	= 4.20
		<u>41,849</u>		<u>105.93</u>

WASTE WATER CONCENTRATION

$$\frac{105.93 \text{ lbs BOD}_5 \times 120,000 \text{ mg/l}}{41,849 \text{ gpd}} = 304 \text{ mg/l}$$

The above figures are generally based upon a usage of 80 gallons per day per person staying 24 hours in the basin. This is a higher usage than mentioned in the above cited report, but we feel it is typical of the life style of the people who visit the park.

We feel that the 41,849 gpd figure should be increased about 20 percent to 50,000 gpd so that the plant is sized closer to what is expected on the peak day of the year. It is on this basis that we recommend treatment capacity of not less than 50,000 gpd.

ESTIMATED FLOW BY MONTH

Using Figure 1 in the "Chisos Basin-Development Concept Plant" report we have developed the following factors for converting the maximum month flow into flows for each of the other months. Assuming a flow during the maximum month of 50,000 gallons per day, then the monthly flows are:

	<u>Factor</u>	<u>Gal/Day</u>
January	.258	12,900
February	.363	18,100
March	.580	29,000
April	.796	39,800
May	.732	36,600
June	.960	48,000
July	.966	48,300
August	1.000	50,000

	<u>Factor</u>	<u>Gal/Day</u>
September	.778	38,800
October	.477	23,800
November	.377	18,800
December	.319	15,900

Because the monthly flows vary considerably during the year creating some months with small flows and some months with large flows, we recommend two treatment units which can operate individually or separately depending upon the seasonal flow. We believe that these units should be of 30,000 GPD and 20,000 GPD capacity and that the 30,000 GPD unit be used by itself during January, February and March. Then the 20,000 GPD unit should be started to help handle the April, May, June, July, August, and September loads. Then during October, November and December the 30,000 GPD unit can operate by itself. Of course it will be up to the plant operator to determine when he should add the additional 20,000 GPD capacity. This may not fall on the first of the month as inferred above.

RECOMMENDED WASTE WATER TREATMENT PLANT

We recommend an activated sludge, extended aeration treatment process because of the high quality effluent produced, its ability to adjust to shock loads, and its ease of operation. The accompanying technical report gives more details and has been prepared for submission to EPA following Texas Water Quality Board procedures and requirements. If it meets with NPS approval, we intend to prepare construction drawings and specifications in such a way that various treatment plant manufacturers may bid on the work instead of specifying a specific manufacturer's plant. We would require that the successful bidder furnish shop drawings of his plant so that we can see that he furnishes a plant which fits within the dimensions and elevations shown on our drawings.

EFFLUENT TESTING REQUIREMENTS AND FLOW MEASUREMENT

To ensure proper operation of the plant we recommend that the following tests and flow measurements be made. Those with an asterisk are minimums recommended by the Texas Water Quality Board.

- | | |
|------------------------------------|-------------------------|
| 1. Instantaneous Flow Measurement* | Twice a Week |
| 2. Relative Stability* | Twice a Week |
| 3. Settleable Solids* | Twice a Week |
| 4. Chlorine residual* | Twice a Week |
| 5. PH | Twice a Week |
| 6. BOD * | Once every Three Months |
| 7. Total Suspended Solids* | Once every Three Months |

It is our intent to have the construction contractor provide the necessary testing equipment for items one through five above. These are simple tests and can be run with a minimum of training. Items six and seven are more complicated and we recommend that NPS make arrangements with a nearby testing laboratory to run these tests.

Myrick-Hewman-Dahlberg, Inc.
March 16, 1973
Page Six

Because tests two through five require relatively simple equipment, we recommend that a laboratory at the plant site not be built, but instead room be set aside in a nearby comfort station or ranger station for the storing of test equipment and running relative stability tests.

CONSTRUCTION COST

A preliminary construction cost estimate amounting to \$145,200 has been made. An itemized listing is included in Exhibit 2.

When you have received comments on this letter from NPS we will begin construction drawings and specifications.

Sincerely,

A handwritten signature in cursive script, appearing to read "Arthur F. Beck".

Arthur F. Beck

jv
Enclosure

**E: TECHNICAL REPORT FOR CHISOS BASIN WASTEWATER
TREATMENT PLANT**

**CHISOS BASIN WASTEWATER
TREATMENT PLANT**

AT

BIG BEND NATIONAL PARK

FOR

U.S. DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE



RAYMOND L. GOODSON, JR. INC.
CONSULTING ENGINEERS

TEXAS WATER QUALITY BOARD

314 W. 11th St.
Austin, Texas 78701

P.O. Box 13246, Capitol Station
Austin, Texas 78711

APPLICATION FOR WASTE CONTROL ORDER
Under Provisions of Article 7621d-1, Vernon's Texas Civil Statutes

All items should be as complete as possible.

See "Instruction and Procedural Information" and "Rules of the Texas Water Quality Board" for additional information.

I. Name
A. Name of Applicant U.D. Department of Interior, National Park Service

Name of Plant, Outlet, Chisos Basin

Permanent mailing address Big Bend National Park, Texas Telephone (915) 477-2251

Zip Code 79834

B. Name, address and telephone number of person or persons authorized to act for applicant during consideration of this application (attorneys, engineering firms, applicant's waste disposal manager, etc.):

Arthur F. Beck, P.E.
Raymond L. Goodson, Jr. Inc.
Consulting Engineers
2909 Lemmon Avenue
Dallas, Texas 75204 (214) 528-2200

II. Type of Waste Control Order:

A. Regular (Original) Original B. Amendment to Waste Control Order No. _____ Page No. _____

III. Nature and Status of Activity:

A. Type of establishment, operation, or process: (for example sulphuric acid plant, steam electric generating plant, oil refinery, mobile home park, etc.) National Park

B. What estimated date will waste disposal operations begin (or if operations have begun, what date did waste disposal operations begin at the site described by this application)? January 1974

C. What estimated date will pollution control facilities described by this application be completed (or if completed, what date were they completed)? (If facilities are to be completed in stages, include schedule of dates of each increment.) Jan. 1974

D. List any other permits or licenses or applications pending for permits or licenses issued by this board or any other governmental entity, whether local, state or federal, which pertain to pollution control activities conducted by this plant or at this location.

None

IV. Location

A. County Brewster

B. Give a general description of the location of the proposed plant with respect to cities, streets, highways, known landmarks, water courses, etc. Include street address if applicable.

Chisos Basin, Big Bend National Park

C. Legal Description

1. Give a legal description of the tract or tracts of land upon which the treatment plant and place of discharge or disposal are located. The term "legal description" means either a metes and bounds description, or the block and lot number of a platted subdivision which has been duly recorded, or any other description which would be suitable to effectuate the transfer of title to real property. The legal description should include a designation of current ownership, and indicate the volume and page number of the latest conveyance to the present owner. (THIS MAY BE SUBMITTED AS A SEPARATE ATTACHMENT TO THIS APPLICATION.)

NOT APPLICABLE

- D. Trace the flow of effluent from the plant to the nearest major watercourse with a word description. (For example: "From the plant site through a six-inch pipe to an unnamed tributary of Doe Creek, then to Doe Creek, then to the Brazos River".) (If no discharge from site is proposed, indicate the method of disposal.)

From stabilization pond to Oak Canyon, a distance of 200 feet;
THENCE approximately 10 miles northwesterly to Rough Run;
THENCE approximately 3 miles southwesterly to Terlingua Creek;
THENCE approximately 15 miles southwesterly to Rio Grande;
ALL within BIG BEND NATIONAL PARK

- E. Submit an application map or maps similar to the sample map in the instructions. More than one map may be used to show the required information. Maps should be on sheets 8½x11 inches or folded to that size, and must include the following information:

1. The approximate boundaries of the tract of land on which the waste disposal activity is or will be conducted.
2. The locations of the point or points of disposal.
3. Known geographic features such as roads, towns, streams, and watercourses.
4. The general character of the areas adjacent to the place or places of disposal such as residential, commercial, recreational, agricultural, undeveloped, etc.
5. The boundaries and ownerships of the tracts of land within a reasonable distance from the applied for point or points of discharge deposit or disposal and in case of disposal to water course, the application shall show the boundaries and ownerships of the tracts of land for a reasonable distance along the water course.
6. The names and addresses (including zip code) of the owners of the tracts of land properly cross-referenced to the tracts of land shown on the map.

- F. Are your waste disposal operations within the extraterritorial jurisdiction of a municipality? No
If so, what municipality? _____

V. Submit a Technical Report in accordance with Part III of Instructions and Procedural information.

VI. List all supplemental maps, drawings, reports, etc., which are submitted herewith as a part of this application.

Technical Report



I, (name) Arthur F. Beck, (title) Consulting Engineer

state that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge and belief. I further state that to the best of my knowledge and belief, the project for which application is made will not in any way violate any law, rule, ordinance, or decree of any duly authorized governmental entity having jurisdiction.

Date March 16, 1973 Signature _____

TECHNICAL REPORT
FOR
CHISOS BASIN WASTE WATER
TREATMENT PLANT
AT
BIG BEND NATIONAL PARK

U.S. DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE

Prepared By:
RAYMOND L. GOODSON, JR. INC.
CONSULTING ENGINEERS
DALLAS, TEXAS

CHISOS BASIN WASTE WATER TREATMENT PLANT
BIG BEND NATIONAL PARK
BREWSTER COUNTY, TEXAS

DESCRIPTION OF PROJECT GENERATING WASTE

The Chisos Basin is a major tourist attraction of the Big Bend National Park located about 260 miles southeast of El Paso in Brewster County (see Figure 1). The basin is surrounded by the Chisos Mountains. Because of its mile high elevation, the basin is cooler in the summer than other parts of the park. Its climate, spectacular views and wild life are strong attractors to tourists. Peaks in the tourist traffic come in April and August when approximately 165 people stay in the motel, 340 people camp in campgrounds, and about 1000 day visitors occupy the basin facilities.

At the present time waste water generated by tourists, concession employees and National Park Service employees is carried through an adequate pipe network to two stabilization ponds having a combined volume of 1,522,000 gallons and surface area of 63,700 square feet. Evaporation from the ponds plus over flowing at certain times of the year is the method of water disposal. Because of a limited water supply and possible deterioration of the environment, it is planned to limit the tourist population to the level at which it is at present.

TYPE OF TREATMENT PLANT AND VOLUME AND QUALITY OF EFFLUENT EXPECTED

Tourist populations vary from month to month with maximums during the summer months and minimums during the winter months. Because of this, it is planned to install two units at the same site which can either operate separately or together (see Figure 2 or Figure 3). The treatment process will be an activated sludge-extended aeration type followed by stabilization ponds. The extended aeration units will be sized to meet the Texas State Health Department requirements as shown in Figure 4 and Figure 5.

It is planned to use the existing stabilization ponds for what additional treatment they might afford. The point of measurement for volume and quality will be at the stabilization pond discharge into Oak Canyon.

Volume and quality parameters are as follows for the peak month:

Average Flow = 42,000 GPD
Maximum Flow = 50,000 GPD
Peak Flow = 87.0 GPM
Design Flow = 50,000 GPD

Item	Not to Exceed		
	Monthly Average	24/Hr./Daily Composite	Individual Sample
B.O.D. (mg/l)	20 mg/l	25 mg/l	30 mg/l
Total Suspended Solids (mg/l)	20 mg/l	25 mg/l	30 mg/l

CHISOS BASIN WASTE WATER TREATMENT PLANT
TECHNICAL REPORT
PAGE TWO

Chlorine residual of not less than 1.0 mg/l after 20 minutes contact time at peak flow.

The disposal of sludge from the sludge holding tank will be to sand drying beds.

DESIGN DATA FOR WASTE TREATMENT

The plant will receive a domestic type sewage from a population equivalent of 525 people during the peak month. Average flow during the peak month is 42,000 GPD at a BOD content of 300 mg/l, producing 105 pounds BOD₅/day and 124 pounds/day total suspended solids.

Due to arid conditions in Brewster County and a low annual rainfall of 15.42 inches, the flows cited above are applicable to both wet and dry weather conditions.

REGIONALIZATION OF FACILITIES

Because of the remoteness of this site regionalization of waste water facilities is not feasible.

RECEIVING WATER COURSE

Flow from the stabilization ponds will be into Oak Canyon. Effluent will flow about 1.7 miles to the "window", thence about 0.4 mile further to Oak Springs, the water supply for Chisos Basin. The water supply is sealed and located at a higher elevation than the stream bed where the effluent will flow. There will be no contamination of the water supply from waste water effluent. From Oak Springs the flow will continue in a northwesterly direction about eight miles to Rough Run; Thence approximately three miles southwesterly to Terlingua Creek; Thence approximately 15 miles southwesterly to Rio Grande River. All of the above is within Big Bend National Park.

Oak Canyon is generally dry. Because of the small quantity of water being discharged from the plant and because the country is arid, it is anticipated that the effluent will evaporate before traveling very far. The land through which the effluent flows is rocky with a grade of six to ten percent inside the basin.

INFILTRATION AND STORM WATER

The present waste water collection system will not be expanded. Because of the slope of the land, storm water runs off before it has a chance to penetrate the soil and infiltrate into the pipes.

The existing stabilization ponds are protected from storm runoff by their location and dikes.

PROPOSED LOCATION
CHISOS BASIN
WASTE WATER PLANT

Existing Sanitary Sewer

Comfort Station

Campgrounds (7 BO Sites)

N.P.S. Housing

Lodge

Scale 1" = 400'

PROPOSED LOCATION
CHISOS BASIN
WASTE WATER PLANT

Existing Sanitary Sewer

Comfort Station

Campgrounds (7 BO Sites)

Overnight & Group Camping

Comfort Station

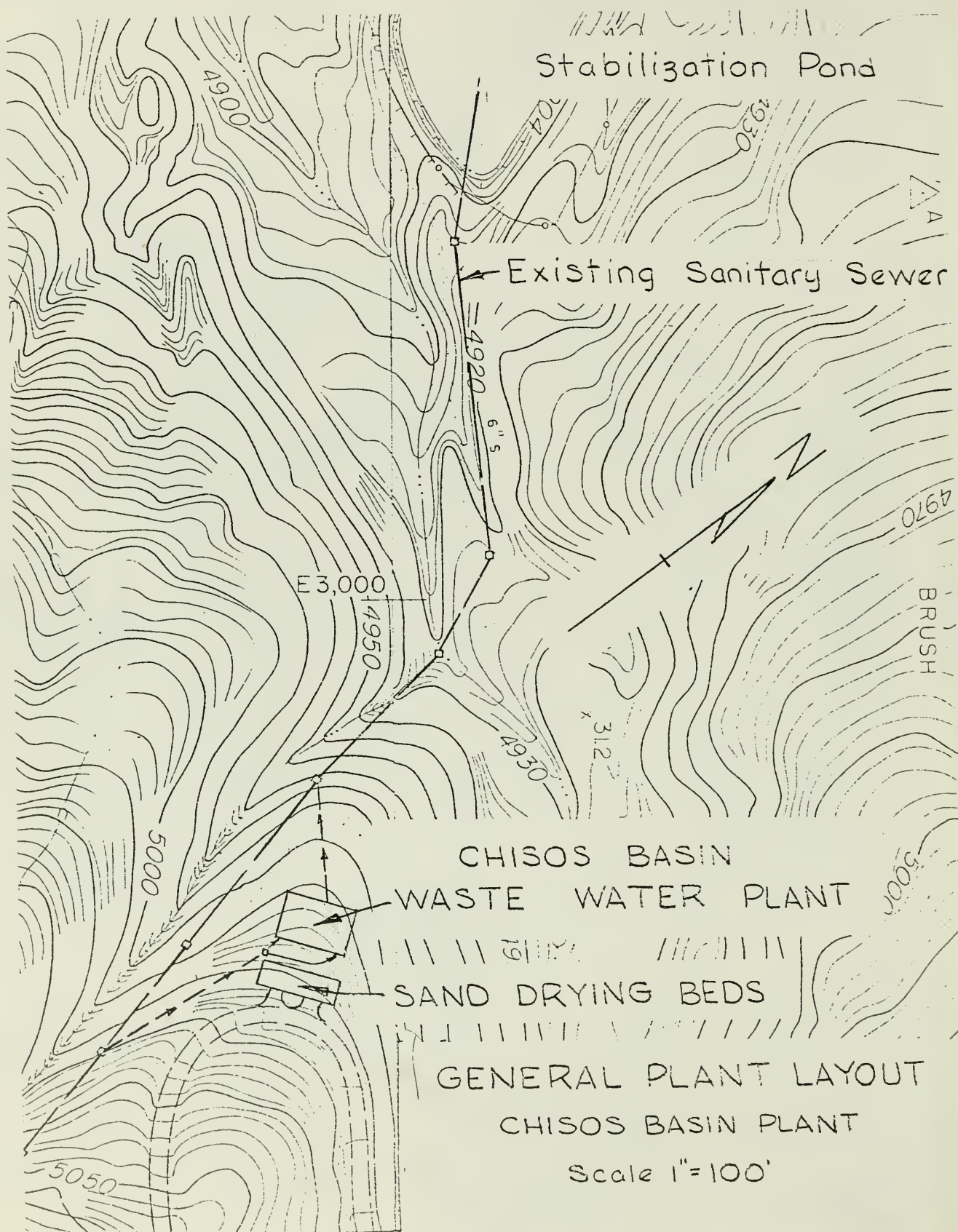
N.P.S. Housing

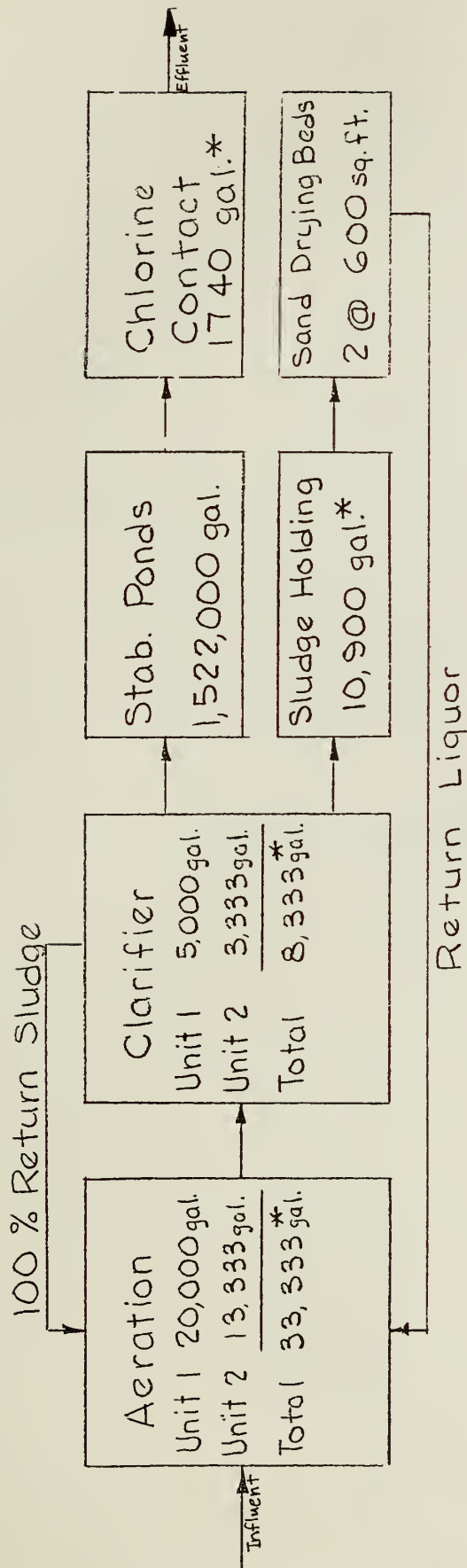
Lodge

Campgrounds

10 Sites to Panther Junction

LOCATION MAP
CHISOS BASIN PLANT
Scale 1" = 400'





24 HOUR CAPACITIES

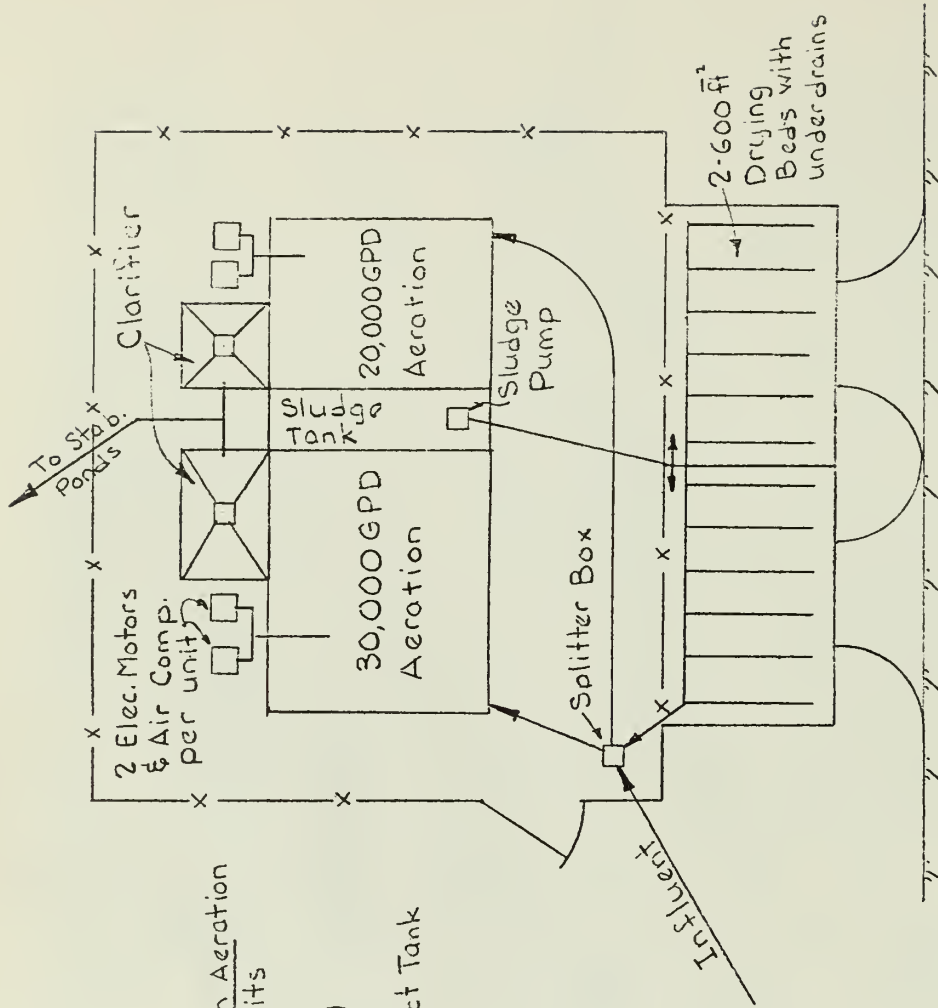
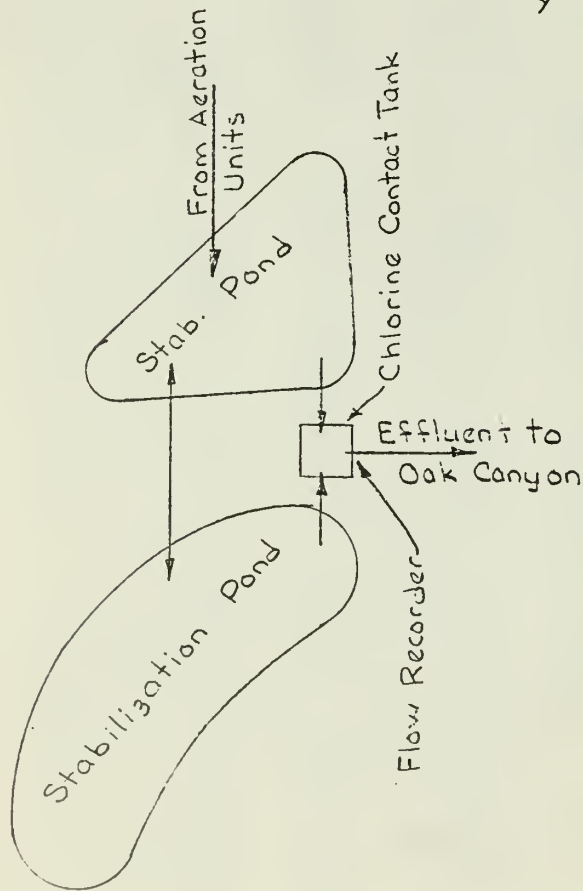
$$\text{Aeration Tank: } 33,333 \text{ gal.} \times \frac{24 \text{ Hr.}}{16 \text{ Hr.}} = 50,000 \text{ GPD}$$

$$\text{Clarifier Tank: } 8,333 \text{ gal.} \times \frac{24 \text{ Hr.}}{4 \text{ Hr.}} = 50,000 \text{ GPD}$$

$$\text{Chlorine Contact Tank: } \frac{\frac{1740 \text{ gal.}}{20 \text{ min.}} \times 1440 \frac{\text{min.}}{\text{day}}}{2.5} = 50,000 \text{ GPD}$$

* Minimum size. Contractor may supply larger size if approved by Engineer.

SCHEMATIC LAYOUT
CHISOS BASIN PLANT
Extended Aeration Process



Note: This is a general layout.
Actual Plant will be
different depending upon
equipment furnished.

PLANT LAYOUT

CHISOS BASIN PLANT

Scale 1" = 20'

F: INFORMATION SHEET, CHISOS MOUNTAIN LODGE

**INFORMATION – CHISOS MOUNTAIN LODGE, BIG BEND NP
(1972 C. Y.)**

1. Rooms and Pillow Count

	Type of Accommodation	Rooms	Pillows
a.	Stone Cottages	6	36
b.	Lodge Units	7	21
		1	2
c.	Motel Units	20	80
d.	"Dallas Huts"	26*	68
	Totals	60	207**

2. Rooms available/year – 20,075; Rooms Occupied – 17,846
Percent of occupancy $17,846/20,075 \times 100 = 88.9\%$.

3. Room guests – Actual – 44,002

- a. Potential based on pillow count – 71,905.
Percent capacity $44,002/71,905 \times 100 = 61.2\%$.
- b. Average guests/room occupied $44,002/17,856 = 2.47$.

4. For forecasting revenues, NPC, Inc., uses an average of 2.5 guests/room and an 86% occupancy factor of rooms – not pillow count.

5. Miscellaneous

- a. Lodge
 - (1) Dining Facilities – Diningroom seats 100 people; coffee shop seats 16 people.

* Actual number available for guests depends on employee requirements.

** Does not include cots or rollaway beds.

- (2) Kitchen — OK except for following:
- (a) needs steam table or equivalent.
 - (b) needs additional refrigeration space.
 - (c) needs frozen food storage (and considerable space for ice storage if this activity is to be moved from service station).
 - (d) a broiler would be desirable, but it is not absolutely necessary.

b. Store grossed \$74,415

Service station grossed \$71,538

c. Concession employees housed and fed at Basin average 60 in number. This number could be reduced considerably if adequate housing were provided so better qualified employees could be interested in working at concession facility.

Publication Services were provided by the graphics and editorial staffs of the Denver Service, Center, December 1974.

United States Department of the Interior / National Park Service NPS 852



